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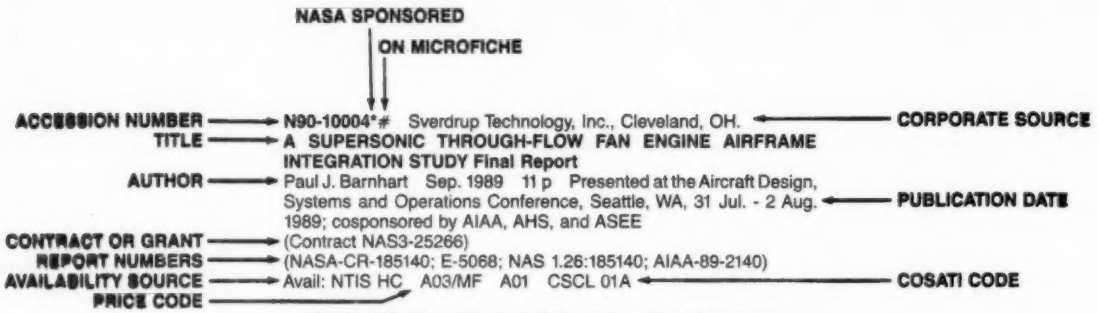
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ACCESSION NUMBER
N90-10004*# Sverdrup Technology, Inc., Cleveland, OH.
CORPORATE SOURCE
TITLE
A SUPERSONIC THROUGH-FLOW FAN ENGINE AIRFRAME INTEGRATION STUDY Final Report
AUTHOR
Paul J. Barnhart Sep. 1989 11 p Presented at the Aircraft Design, Systems and Operations Conference, Seattle, WA, 31 Jul. - 2 Aug. 1989; cosponsored by AIAA, AHS, and ASEE
PUBLICATION DATE
CONTRACT OR GRANT
(Contract NAS3-25266)
REPORT NUMBERS
(NASA-CR-185140; E-5068; NAS 1.26:185140; AIAA-89-2140)
AVAILABILITY SOURCE
Avail: NTIS HC A03/MF A01 CSCL 01A
COSATI CODE
PRICE CODE

Engine airframe integration effects are investigated for superonsic through-flow fan engines installed on a Mach 3.20 supersonic cruise vehicle. Six different supersonic through-flow fan engine installations covering the effects of engine size, nacelle contour, nacelle placement, and approximate bypass plume effects are presented. The different supersonic through-flow fan installations are compared with a conventional turbine bypass engine configuration on the same basic airframe. The supersonic through-flow fan engine integrations are shown to be comparable to the turbine bypass engine configuration on the basis of installed nacelle wave drag. The supersonic through-flow fan engine airframe integrated vehicles have superior aerodynamic performance on the basis of maximum lift-to-drag ratio than the turbine bypass engine installation over the entire operating Mach number range from 1.10 to 3.20. When approximate bypass plume modeling is included, the supersonic through-flow fan engine configuration shows even larger improvements over the turbine bypass engine configuration. Author

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Scientific and Technical Aerospace Reports

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01 AERONAUTICS (GENERAL)

N90-17537* National Aeronautics and Space Administration, Washington, DC.
AERONAUTICAL ENGINEERING: A CONTINUING BIBLIOGRAPHY WITH INDEXES (SUPPLEMENT 247)
Jan. 1990 125 p
(NASA-SP-7037(247); NAS 1.21:7037(247)) Avail: NTIS HC A06; NTIS standing order as PB89-914100, $10.50 domestic, $21.00 foreign CSCL 01B

This bibliography lists 437 reports, articles, and other documents introduced into the NASA scientific and technical information system in December, 1989. Subject coverage includes: design, construction and testing of aircraft and aircraft engines; aircraft components, equipment and systems; ground support systems; and theoretical and applied aspects of aerodynamics and general fluid dynamics. Author

02 AERODYNAMICS

Includes aerodynamics of bodies, combinations, wings, rotors, and control surfaces; and internal flow in ducts and turbomachinery.

For related information see also *34 Fluid Mechanics and Heat Transfer.*

N90-17538 Stanford Univ., CA.
STUDY OF CONTINUUM HIGHER ORDER CLOSURE MODELS EVALUATED BY A STATISTICAL THEORY OF SHOCK STRUCTURE Ph.D. Thesis
Kurt Alan Fiscko 1988 124 p
Avail: Univ. Microfilms Order No. DA8906661

New generations of vehicles flying through planetary atmospheres at high speeds and altitudes, such as the Aero-assist Orbital Transfer Vehicle, will operate in flight regimes where the atmosphere may be considered a continuum, but where the conventional continuum equations of Navier-Stokes fail to yield accurate results. These conditions may be characterized by a bow shock wave thickness that is comparable to the shock stand-off distance from the hard body. The Navier-Stokes equations fail to correctly predict shock density thickness, density asymmetry, and temperature-density separation for all but very low Mach number shock waves. This research was undertaken to develop improvements to the continuum model which will yield accurate numerical solutions within hypersonic shock waves of monatomic gases. The Direct Simulation Monte Carlo method is used to calculate particulate solutions for shock structure, and provide more information about the shock wave than is experimentally available. These statistical simulations have indicated a strong correlation between higher order flow variable derivatives and the viscous stress needed to improve the Navier-Stokes equations. Further, these simulations showed that the Fourier law of heat conduction used in the continuum equations is not adequate for hypersonic shock waves. Attempts at developing empirical models containing this information proved futile. Dissert. Abstr.

N90-17539*# West Virginia Univ., Morgantown. Dept. of Mechanical and Aerospace Engineering.
COMPUTATIONAL DESIGN OF LOW ASPECT RATIO WING-WINGLET CONFIGURATIONS FOR TRANSONIC WIND-TUNNEL TESTS Final Report, Jan. 1987 - May 1989
John M. Kuhlman and Christopher K. Brown Oct. 1989 114 p (Grant NAG1-625)
(NASA-CR-181939; NAS 1.26:181939) Avail: NTIS HC A06/MF A01 CSCL 01A

Computational designs were performed for three different low aspect ratio wing planforms fitted with nonplanar winglets; one of the three configurations was selected to be constructed as a wind tunnel model for testing in the NASA LaRC 8-foot transonic pressure tunnel. A design point of M = 0.8, C(sub L) is approximate or = to 0.3 was selected, for wings of aspect ratio equal to 2.2, and leading edge sweep angles of 45 deg and 50 deg. Winglet length is 15 percent of the wing semispan, with a cant angle of 15 deg, and a leading edge sweep of 50 deg. Winglet total area equals 2.25 percent of the wing reference area. The design process and the predicted transonic performance are summarized for each configuration. In addition, a companion low-speed design study was conducted, using one of the transonic design wing-winglet planforms but with different camber and thickness distributions. A low-speed wind tunnel model was constructed to match this low-speed design geometry, and force coefficient data were obtained for the model at speeds of 100 to 150 ft/sec. Measured drag coefficient reductions were of the same order of magnitude as those predicted by numerical subsonic performance predictions. Author

N90-17540 Nielsen Engineering and Research, Inc., Mountain View, CA.
MISSILE AERODYNAMICS: NEAR CONFERENCE ON MISSILE AERODYNAMICS
Michael R. Mendenhall, ed., David Nixon, ed., and Marnix F. E. Dillenius, ed. 1989 620 p Conference held in Monterey, CA, 31 Oct. - 2 Nov. 1988
(ISBN-0-9620629-1-X; LC-89-38136) Copyright Avail: Issuing Activity

Several aspects of missile aerodynamics were discussed at the conference held in Monterey, California from Oct. 31 to Nov. 2, 1988. Missile aerodynamics from an historical perspective, a critical assessment of prediction capabilities, external store separation and aircraft/store integration, the role of computational fluid dynamics in missile aerodynamics, heat transfer computation methods, and the use of lateral jet control are among the topics discussed. For individual titles, see N90-17541 through N90-17554.

N90-17541 Aerospatiale, Chatillon (France). Div. Engins Tactiques.
A SURVEY OF MISSILE AERODYNAMICS
R. G. Lacau *In* Nielsen Engineering and Research, Inc., Missile Aerodynamics: NEAR Conference on Missile Aerodynamics 1989 54 p (For primary document see N90-17540 10-02)
Copyright Avail: Issuing Activity

A general review of tactical missile aerodynamics is given. The different aspects considered are: the general aerodynamic design considerations, the specifics of tactical missile aerodynamics, the different aerodynamic studies, the engineering computational codes

and the wind tunnel testing. Because of the recent interest in long range, high speed and highly maneuverable missiles, special attention is focussed on control configurations and supersonic airbreathing missiles. The engineering codes presented cover semi-empirical methods and numerical methods based on the resolution of the Euler equations, with or without flow separation. They are presented from an industrial point of view and illustrated by numerous examples. Author

N90-17542* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
HISTORICAL REVIEW OF MISSILE AERODYNAMIC DEVELOPMENTS
M. Leroy Spearman *In* Nielsen Engineering and Research, Inc., Missile Aerodynamics: NEAR Conference on Missile Aerodynamics 1989 34 p (For primary document see N90-17540 10-02)
Copyright Avail: Issuing Activity CSCL 01A

The development of missiles from early history up to about 1970 is discussed. Early unpowered missiles beyond the rock include the spear, the bow and arrow, the gun and bullet, and the cannon and projectile. Combining gunpowder with projectiles resulted in the first powered missiles. In the early 1900's, the development of guided missiles was begun. Significant advances in missile technology were made by German scientists during World War II. The dispersion of these advances to other countries following the war resulted in accelerating the development of guided missiles. In the late 1940's and early 1950's there was a proliferation in the development of missile systems in many countries. These developments were based primarily on experimental work and on relatively crude analytical techniques. Discussed here are some of the missile systems that were developed up to about 1970; some of the problems encountered; the development of an experimental data base for use with missiles; and early efforts to develop analytical methods applicable to missiles. Author

N90-17543 Lockheed Missiles and Space Co., Sunnyvale, CA.
MISSILE DYNAMICS: A CRITICAL ASSESSMENT OF PREDICTION CAPABILITIES
L. E. Ericsson *In* Nielsen Engineering and Research, Inc., Missile Aerodynamics: NEAR Conference on Missile Aerodynamics 1989 35 p (For primary document see N90-17540 10-02)
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The aerodynamic information needed for preliminary design of tactical missiles has always been obtained through the combined use of theory and experiments. In regard to the static aerodynamics, this has resulted in a prediction capability that often is satisfactory for preliminary design. However, the vehicle dynamics cannot be predicted with the same confidence, especially not at the high angles of attack where high performance missiles often must operate. In this case we are still dependent upon continuous efficient interaction between theoretical and experimental methods. Delineated here are the limitations of both methods. Ways to circumvent them in order to predict tactical missile dynamics over the required range of operational parameters are noted. Author

N90-17544 Integrated Systems, Inc., Santa Clara, CA.
APPROPRIATE AEROPREDICTION ACCURACY IN DEFINING MISSILE SYSTEMS FOR AERODYNAMIC FLIGHT
M. Michael Briggs and Min-Jea Tahk *In* Nielsen Engineering and Research, Inc., Missile Aerodynamics: NEAR Conference on Missile Aerodynamics 1989 41 p (For primary document see N90-17540 10-02)
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An assessment of aeroprediction accuracy needed to adequately support the definition of missile systems for aerodynamic flight is carried out based upon the idea that aerodynamic requirements must be augmented to account for aeroprediction uncertainties. The flowdown of system performance requirements to aerodynamic requirements is illustrated, and examples of how uncertainty-augmented aerodynamic requirements impact subsystem weights are provided. It is argued that requirements-responsive design demands assurance that the system requirements will always be satisfied in the presence of parameter uncertainties, leading to a likelihood that the system will be oversized and deliver performance in excess of what is minimally required. Relationships between aeroprediction uncertainties and probable excess subsystem mass are developed. The propulsion subsystem mass is shown to be the most effected, especially for missiles that employ airbreathing propulsion. The most important source of aerodynamic uncertainty is shown to be that of drag coefficient at the desired lift coefficient magnitude, or effectively, the operational lift/drag ratio. Author

N90-17545 Aircraft Research Association Ltd., Bedford (England).
APPLICATION OF EXPERIMENTAL TECHNIQUES TO STORE RELEASE PROBLEMS
Marylyn E. Wood *In* Nielsen Engineering and Research, Inc., Missile Aerodynamics: NEAR Conference on Missile Aerodynamics 1989 45 p (For primary document see N90-17540 10-02)
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The various experimental techniques for the prediction of store release characteristics are reviewed and recent advances to the simulation capabilities are described. Examples of the application of these techniques to a wide range of store release problems are given and comparisons made with predictions by other computational ground-based methods and with flight. The value of developing an integrated method which combines wind tunnel data with a mathematical model to assess aircraft safety/store separation characteristics with a high level of confidence is strongly emphasized. Author

N90-17546 Calspan Corp., Arnold AFS, TN. Flight Dynamics Section.
USE OF SEMIEMPIRICAL AERODYNAMIC METHODS FOR PRELIMINARY DESIGN
William B. Baker, Jr. *In* Nielsen Engineering and Research, Inc., Missile Aerodynamics: NEAR Conference on Missile Aerodynamics 1989 35 p (For primary document see N90-17540 10-02)
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A brief review is given of the role of the aerodynamicist in preliminary design and the semiempirical tools available to accomplish the job. Some of the tasks assigned to the aerodynamicist are described and the required accuracy of the predicted results is given. A description of the basic formulation of the semiempirical codes is provided along with some of the fundamental techniques used in most codes. Several typical semiempirical codes are discussed and the basic capabilities of the codes are compared in tabular form. Several critical comparisons of two or more codes are reviewed. In each case the codes were compared against experimental data for various missiles and stores. The missiles are representative of conventional missiles, lifting missiles, airbreathers, and cruise missiles. The stores are representative of bombs, dispensers, and fuel tanks. An interactive graphics system is described which allows simplified input for a number of semiempirical codes. The program includes a basic expert system function which assists the analyst with the selection of the codes to run for a given configuration. Some areas of required improvement are also highlighted. Author

N90-17547 National Aerospace Lab., Amsterdam (Netherlands).
THE ROLE OF COMPUTATIONAL FLUID DYNAMICS IN MISSILE AERODYNAMICS
H. W. M. Hoeijmakers *In* Nielsen Engineering and Research, Inc., Missile Aerodynamics: NEAR Conference on Missile Aerodynamics 1989 50 p (For primary document see N90-17540 10-02)
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The application of computational fluid dynamics methods in the analysis of the aerodynamic characteristics of missile configurations is reviewed. The aerodynamics of missile configurations concerns the flow about geometrically complex configurations to be analyzed for a broad range of the flight parameters. The flow can be very complex being dominated by

vortical flow structures which at higher speed interact with shock waves. The capability of computational procedures to simulate missile aerodynamics is described. The advantages and disadvantages of using flow models of various levels of approximation are noted. Author

N90-17548* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
A REVIEW OF HIGH-SPEED, CONVECTIVE, HEAT-TRANSFER COMPUTATION METHODS
Michael E. Tauber *In* Nielsen Engineering and Research, Inc., Missile Aerodynamics: NEAR Conference on Missile Aerodynamics 1989 64 p (For primary document see N90-17540 10-02)
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The objective is to provide useful engineering formulations and to instill a modest degree of physical understanding of the phenomena governing convective aerodynamic heating at high flight speeds. Some physical insight is not only essential to the application of the information presented here, but also to the effective use of computer codes which may be available to the reader. Given first is a discussion of cold-wall, laminar boundary layer heating. A brief presentation of the complex boundary layer transition phenomenon follows. Next, cold-wall turbulent boundary layer heating is discussed. This topic is followed by a brief coverage of separated flow-region and shock-interaction heating. A review of heat protection methods follows, including the influence of mass addition on laminar and turbulent boundary layers. Next is a discussion of finite-difference computer codes and a comparison of some results from these codes. An extensive list of references is also provided from sources such as the various AIAA journals and NASA reports which are available in the open literature. Author

N90-17549 Nielsen Engineering and Research, Inc., Mountain View, CA.
PREDICTION METHODS FOR STORE SEPARATION
Marnix F. E. Dillenius and David Nixon *In its* Missile Aerodynamics: NEAR Conference on Missile Aerodynamics 1989 71 p (For primary document see N90-17540 10-02)
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Theoretical approaches to the prediction of store separation characteristics are discussed. Historical developments of both the traditional engineering level and the much more recent CFD based methods are outlined. Various aspects of aircraft/store aerodynamic interference are pointed out. Early methods and methods presently in use and described in the open literature are discussed and examples given of their applications. The present engineering level methods include the NEAR programs and the AEDC direct method. The basic aspects of existing CFD technology are summarized, and specific applications to aircraft/store configurations are described. Given here are recommendations for future developments in predictive technology for store separation characteristics. Author

N90-17550 McDonnell-Douglas Astronautics Co., Saint Louis, MO.
HIGH PERFORMANCE MISSILES OF THE FUTURE
R. J. Krieger and J. E. Williams *In* Nielsen Engineering and Research, Inc., Missile Aerodynamics: NEAR Conference on Missile Aerodynamics 1989 29 p (For primary document see N90-17540 10-02)
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Requirements and concepts for future, high performance cruise and maneuvering missiles are discussed. Configuration features for high altitude supersonic or hypersonic cruise missiles and highly maneuverable air-intercept missiles are described. Many of the features for future cruise and maneuvering missiles were identified and wind tunnel tested as part of the U.S. Air Force sponsored Aerodynamic Configured Missile (ACM) Program. These results are summarized with emphasis on the impact of these studies on future missile concepts. Many of the features are shown to be compatible with performance, carriage and survivability requirements. Author

N90-17551 Aerospatiale, Chatillon (France). Div. Engins Tactiques.
THE USE OF LATERAL JET CONTROL AT AEROSPATIALE **c08**
R. G. Lacau and M. Robert *In* Nielsen Engineering and Research, Inc., Missile Aerodynamics: NEAR Conference on Missile Aerodynamics 1989 16 p (For primary document see N90-17540 10-02)
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Pyrotechnical lateral force control is discussed. The interest in this type of control and its application for two aerospatiale missiles, the short-range antitank ERYX and the SAAM ASTER, are discussed. Also discussed are the main aerodynamic aspects of the lateral jets, classified in local and downstream interactions. The aerodynamic studies, experimental and theoretical, required for developing the aerodynamic configuration of the ASTER compatible with this lateral force control concept are covered. Author

N90-17552 ARMCON, Inc., Shalimar, FL.
THE INTEGRATION OF STORES ON MODERN TACTICAL AIRCRAFT: WHERE WE HAVE BEEN, AND WHAT WE SHOULD DO FOR THE FUTURE **c05**
Charles S. Epstein *In* Nielsen Engineering and Research, Inc., Missile Aerodynamics: NEAR Conference on Missile Aerodynamics 1989 23 p (For primary document see N90-17540 10-02)
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In the years since World War II, although the technological development of aircraft and their weapons has been impressive, there has not been a corresponding program to insure efficient aircraft/weapons compatibility. The lack of a coordinated aircraft/weapons compatibility plan has resulted in spectacularly performing clean aircraft which must suffer significant performance degradations when the stores are installed. The methods of store carriage used in the past, those available to the aircraft and store designers today, and methods which can be used in the future are discussed. Finally, a plea is made for close coordination between the aircraft and the store designers, and for the services to be more realistic in the requirements for tactical aircraft. Author

N90-17553 Loral Defense Systems, Akron, OH.
VLA MISSILE DEVELOPMENT AND HIGH ANGLE OF ATTACK BEHAVIOR
Anthony L. Dunne, Samuel Black, Gordon S. Schmidt, and Thomas L. Lewis (Naval Ocean Systems Center, San Diego, CA.) *In* Nielsen Engineering and Research, Inc., Missile Aerodynamics: NEAR Conference on Missile Aerodynamics 1989 72 p (For primary document see N90-17540 10-02)
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The Vertical Launch ASROC (VLA) is a ship-launched, three stage, Anti-Submarine Warfare weapon. Its initial pushover maneuver involves angles of attack up to 70 degrees. Reviewed here are the evolution and development of VLA's unique features. An aerodynamic investigation following the errant flight of a test vehicle while executing the pushover maneuver is discussed. The behavior, attributed to yawing moments 150 percent larger than measured in wind tunnel tests, led to a new series of wind tunnel and flight tests to determine the cause and explore fixes. Using detailed models of a forebody alone and a complete configuration, tests in AEDC 16T provided data at flight Reynolds numbers for angles of attack up to 84 degrees. Suspected nose tip movement was investigated along with fixes such as strakes and other devices. Differences between yawing moment contributions to the forebody and to the complete missile were observed. The flight test yawing moments could nearly be reproduced with a canted nose tip. Wind tunnel pressure distribution data on the forebody showed good agreement with inflight measurements on a subsequent test vehicle with a fixed nose tip which successfully performed the earlier mission. Author

N90-17554 Dornier-Werke G.m.b.H., Friedrichshafen (Germany, F.R.).
DYNAMIC DERIVATIVES OF MISSILES AND FIGHTER-TYPE CONFIGURATIONS AT HIGH ANGLES OF ATTACK c05
Heinz Fuchs *In* Nielsen Engineering and Research, Inc., Missile Aerodynamics: NEAR Conference on Missile Aerodynamics 1989 21 p (For primary document see N90-17540 10-02)
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The prediction methodology of dynamic derivatives is presented as derived from semiempirical calculation procedures like USAF Stability and Control Datcom in combination with some modifications necessary for tactical missile configurations at higher angles-of-attack. The main subject is the treatment of longitudinal stability derivatives and of roll damping derivativum. A comparison of theoretical and experimental results is presented. Different dynamic wind tunnel test equipment are explained including the data evaluation theory. Some aspects of modification of the present linear data evaluation method nonlinear terms at high angles-of-attack are shown with an example of a fighter aircraft configuration using the MOD test rig in the Dornier wind tunnel. Especially, the phenomenon of dynamic lift beyond dynamic stall is shown for sinusoidal oscillations of small reduced frequencies. Author

N90-17555*# Institute for Computer Applications in Science and Engineering, Hampton, VA.
GOERTLER VORTICES IN GROWING BOUNDARY LAYERS: THE LEADING EDGE RECEPTIVITY PROBLEM, LINEAR GROWTH AND THE NONLINEAR BREAKDOWN STAGE Final Report
Philip Hall (Exeter Univ., England) Dec. 1989 75 p Submitted for publication
(Contract NAS1-18605)
(NASA-CR-181962; ICASE-89-81; NAS 1.26:181962) Avail: NTIS HC A04/MF A01 CSCL 01A

Goertler vortices are thought to be the cause of transition in many fluid flows of practical importance. A review of the different stages of vortex growth is given. In the linear regime, nonparallel effects completely govern this growth, and parallel flow theories do not capture the essential features of the development of the vortices. A detailed comparison between the parallel and nonparallel theories is given and it is shown that at small vortex wavelengths, the parallel flow theories have some validity; otherwise nonparallel effects are dominant. New results for the receptivity problem for Goertler vortices are given; in particular vortices induced by free stream perturbations impinging on the leading edge of the walls are considered. It is found that the most dangerous mode of this type can be isolated and it's neutral curve is determined. This curve agrees very closely with the available experimental data. A discussion of the different regimes of growth of nonlinear vortices is also given. Again it is shown that, unless the vortex wavelength is small, nonparallel effects are dominant. Some new results for nonlinear vortices of 0(1) wavelengths are given and compared to experimental observations. Author

N90-17556 Old Dominion Univ., Norfolk, VA.
LOW SPEED FLOWFIELD CHARACTERIZATION BY INFRARED MEASUREMENTS OF SURFACE TEMPERATURES Ph.D. Thesis
Ehud Gartenberg 1989 165 p
Avail: Univ. Microfilms Order No. DA8925387

An experimental program was aimed at identifying areas in low speed aerodynamic research where infrared imaging systems can make significant contributions. Implementing a new technique, a long electrically heated wire was placed across a laminar jet. By measuring the temperature distribution along the wire with the IR imaging camera, the flow behavior was identified. Furthermore, using Nusselt number correlations, the velocity distribution could be deduced. The same approach was used to survey wakes behind cylinders in a wind-tunnel. This method is suited to investigate flows with position dependent velocities, e.g., boundary layers, confined flows, jets, wakes, and shear layers. It was found that the IR imaging camera cannot accurately track high gradient temperature fields. A correction procedure was devised to account for this limitation. Other wind-tunnel experiments include tracking the development of the laminar boundary layer over a warmed flat plate by measuring the chordwise temperature distribution. This technique was applied also to the flow downstream from a rearward facing step. Finally, the IR imaging system was used to study boundary layer behavior over an airfoil at angles of attack from zero up to separation. The results were confirmed with tufts observable both visually and with the IR imaging camera. Dissert. Abstr.

N90-17557 Pennsylvania State Univ., University Park.
SKIN FRICTION MEASUREMENTS BY LASER INTERFEROMETRY IN SUPERSONIC FLOWS Ph.D. Thesis
Kwang-Soo Kim 1989 229 p
Avail: Univ. Microfilms Order No. DA8922069

The measurement of skin friction in complex compressible flows is difficult, and very few reliable techniques are available. A recent development, the Laser Interferometer Skin Friction (LISF) meter, is shown to be useful for this purpose. This technique interferometrically measures the time rate of thinning of an oil film applied to an aerodynamic surface. Under proper conditions the wall shear stress may thus be found directly, without reference to flow properties. For the calibration of the LISF meter, the technique is initially applied to supersonic flat plate turbulent boundary layers at nominal Mach numbers of 2.5, 3.0, 3.5, and 4.0. Its accuracy and repeatability are assessed, and conditions required for its successful application are described. The LISF technique is also applied to obtain reliable skin friction data in 3-D swept shock wave/turbulent bounday layer interactions. Two sets of experiments are performed at a nominal Mach number of 3.0, and at fin shock-generator angles of 10 and 16 degrees. The results show that such measurements are practical in high speed interacting flows, and that a repeatability of plus or minus 6 percent or better is obtained. Further, useful information is gained on the behavior of the wall shear stress beneath swept shock wave/boundary layer interactions. Finally, these data are used in a computational fluid dynamics (CFD) code validation exercise. Dissert. Abstr.

N90-17558*# Notre Dame Univ., IN. Dept. of Aerospace and Mechanical Engineering.
SURFACE PRESSURE DISTRIBUTIONS ON A DELTA WING UNDERGOING LARGE AMPLITUDE PITCHING OSCILLATIONS M.S. Thesis
Scott A. Thompson Dec. 1989 171 p
(Grant NAG1-727)
(NASA-CR-186326; NAS 1.26:186326) Avail: NTIS HC A08/MF A01 CSCL 01A

Wind tunnel experiments were performed on a 70 deg sweep delta wing to determine the effect of a sinusoidal pitching motion on the pressure field on the suction side of the wing. Twelve pressure taps were placed from 35 to 90 percent of the chord, at 60 percent of the local semi-span. Pressure coefficients were measured as a function of Reynolds number and pitch rate. The pressure coefficient was seen to vary at approximately the same frequency as the pitching frequency. The relative pressure variation at each chord location was comparable for each case. The average pressure distribution through each periodic motion was near the static distribution for the average angle of attack. Upon comparing the upstroke and downstroke pressures for a specific angle of attack, the downstroke pressures were slightly larger. Vortex breakdown was seen to have the most significant effect at the 40 to 45 percent chord location, where a decrease in pressure was apparent. Author

N90-17559*# Institute for Computer Applications in Science and Engineering, Hampton, VA.
TS - DEAN INTERACTIONS IN CURVED CHANNEL FLOW Final Report
Bart A. Singer, Thomas A. Zang, and Gordon Erlebacher Jan. 1990 45 p Submitted for publication

(Contract NAS1-18605)
(NASA-CR-181983; NAS 1.26:181983; ICASE-90-9) Avail: NTIS HC A03/MF A01 CSCL 01A

A weakly nonlinear theory is developed to study the interaction of TS waves and Dean vortices in curved channel flow. The prediction obtained from the theory agree well with results obtained from direct numerical simulations of curved channel flow, especially for low amplitude disturbances. At low Reynolds numbers the wave interaction is generally stabilizing to both disturbances, though as the Reynolds number increases, many linearly unstable TS waves are further destabilized by the presence of Dean vortices.

Author

N90-17560*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

SUPERSONIC AERODYNAMIC CHARACTERISTICS OF A PROPOSED ASSURED CREW RETURN CAPABILITY (ACRC) LIFTING-BODY CONFIGURATION

George M. Ware Nov. 1989 75 p
(NASA-TM-4136; L-16627; NAS 1.15:4136) Avail: NTIS HC A04/MF A01 CSCL 01A

An investigation was conducted in the Langley Unitary Plan Wind Tunnel at Mach numbers from 1.6 to 4.5. The model had a low-aspect-ratio body with a flat undersurface. A center fin and two outboard fins were mounted on the aft portion of the upper body. The outboard fins were rolled outboard 40 deg from the vertical. Elevon surfaces made up the trailing edges of the outboard fins, and body flaps were located on the upper and lower aft fuselage. The center fin pivoted about its midchord for yaw control. The model was longitudinally stable about the design center-of-gravity position at 54 percent of the body length. The configuration with undeflected longitudinal controls trimmed near 0 deg angle of attack at Mach numbers from 1.6 to 3.0 where lift and lift-drag ratio were negative. Longitudinal trim was near the maximum lift-drag ratio (1.4) at Mach 4.5. The model was directionally stable over Mach number range except at angles of attack around 4 deg at $M = 2.5$. Pitch control deflection of more than -10 deg with either elevons or body flaps is needed to trim the model to angles of attack at which lift becomes positive. With increased control deflection, the lifting-body configuration should perform the assured crew return mission through the supersonic speed range.

Author

N90-17561*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

ENGINE INLET DISTORTION IN A 9.2 PERCENT SCALE VECTORED THRUST STOVL MODEL IN GROUND EFFECT

Albert L. Johns, George Neiner, J. D. Flood, K. C. Amuedo, and T. W. Strock (McDonnell-Douglas Corp., Saint Louis, MO.) 1989 24 p Presented at the 25th Joint Propulsion Conference, Monterey, CA, 10-12 Jul. 1989; cosponsored by AIAA, ASME, SAE, and ASEE
(NASA-TM-102358; E-5072; NAS 1.15:102358; AIAA-89-2910)
Avail: NTIS HC A03/MF A01 CSCL 01A

Advanced Short Takeoff/Vertical Landing (STOVL) aircraft which can operate from remote locations, damaged runways, and small air capable ships are being pursued for deployment around the turn of the century. To achieve this goal, NASA Lewis Research Center, McDonnell Douglas Aircraft, and DARPA defined a cooperative program for testing in the NASA Lewis 9- by 15-foot low speed wind tunnel (LSWT) to establish a database for hot gas ingestion, one of the technologies critical to STOVL. Results are presented which show the engine inlet distortions (both temperature and pressure) in a 9.2 percent scale vectored thrust STOVL model in ground effects. Results are shown for the forward nozzle splay angles of 0 degrees, -6 degrees, and 18 degrees. The model support system had 4 degrees of freedom, heated high pressure air for nozzle flow, and a suction system exhaust for inlet flow. The headwind (freestream) velocity was varied from 8 to 23 knots.

Author

N90-17562*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

NUMERICAL SOLUTIONS OF THE LINEARIZED EULER EQUATIONS FOR UNSTEADY VORTICAL FLOWS AROUND LIFTING AIRFOILS

James R. Scott and Hafiz M. Atassi (Notre Dame Univ., IN.) 1990 21 p Presented at the 28th Aerospace Sciences Meeting, 8-11 Jan. 1990; sponsored by AIAA
(NASA-TM-102466; E-5137; NAS 1.15:102466; AIAA-90-0694)
Avail: NTIS HC A03/MF A01 CSCL 01A

A linearized unsteady aerodynamic analysis is presented for unsteady, subsonic vortical flows around lifting airfoils. The analysis fully accounts for the distortion effects of the nonuniform mean flow on the imposed vortical disturbances. A frequency domain numerical scheme which implements this linearized approach is described, and numerical results are presented for a large variety of flow configurations. The results demonstrate the effects of airfoil thickness, angle of attack, camber, and Mach number on the unsteady lift and moment of airfoils subjected to periodic vortical gusts. The results show that mean flow distortion can have a very strong effect on the airfoil unsteady response, and that the effect depends strongly upon the reduced frequency, Mach number, and gust wave numbers.

Author

N90-17563 Texas Univ., Arlington.

LARGE-EDDY INTERACTION MODEL IN THE TURBULENT WAKE OF A CIRCULAR CYLINDER Ph.D. Thesis

Chang-Soo Ahn 1989 118 p
Avail: Univ. Microfilms Order No. DA9000948

A turbulence model that describes dynamics of large, characteristic eddies in inhomogeneous flows is proposed; two closure parameters are initially undetermined. To determine the optimum values of these parameters, the present model is applied to wake flow. To solve the coupled, nonlinear, parabolic governing equations, new numerics are developed, and combined with DFI and FDM. Numerical results are presented and compared with experimental data in order to show the applicability and the effectiveness of the current procedures. The nature of the closure parameters and their effects upon predicted Reynolds stresses and other turbulence structural quantities are examined and optimum values are suggested. It is demonstrated that the current Large-Eddy Interaction Model not only predicts Reynolds stresses reasonably well but also illuminates typical characteristic large-scale motions in turbulence wake flow.

Dissert. Abstr.

N90-17564 Cincinnati Univ., OH.

ANALYSIS AND NUMERICAL SOLUTION OF FLOW OVER AIRFOIL WITH CONTROL FLAP Ph.D. Thesis

Cheng-Wei Liao 1989 220 p
Avail: Univ. Microfilms Order No. DA9003254

The purpose of this research is to achieve and analyze numerical solutions and aerodynamic properties of the NACA0012 airfoil with and without control flap, at different angles of attack. A numerical grid-generation based on conformal mapping is employed to develop an othogonal surface-oriented coordinate system for the complex geometry of the air foil with general orientation of the control flap. The Navier-Stokes equations are solved by using the ARC2D code developed by the NASA Ames Research Center. The code solves the thin-layer Navier-Stokes equations by implicit finite-difference scheme using time linearization, approximate factorization and diagonalization of the coefficient of matrix. For the basic NACA0012 airfoil, comparison of the numerical solutions with experimental data shows that the numerical predictions are quite good. For the airfoil with control flap, the numerical solutions obtained are persistently unsteady. Mach contour and pressure contour are used to demonstrate the flow structure. The capability developed for generating grid and determining the flow for airfoil with a control flap provides the foundations for innovative airfoil-flap design and flow control.

Dissert. Abstr.

N90-17565# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Fluid Dynamics Panel.
SPECIAL COURSE ON THREE-DIMENSIONAL SUPERSONIC/HYPERSONIC FLOWS INCLUDING SEPARATION
Jan. 1990 395 p Special course held in Rhode-Saint-Genese, Belgium, 8-12 May 1989, and at Moffett Field, CA, 10-14 Jul. 1989
(AGARD-R-764; ISBN-92-835-0537-9) Copyright Avail: NTIS HC A17/MF A03; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

The objective was to provide a status report on the understanding and ability to predict three-dimensional compressible flows including the complex effects of flow separation. An overview presentation of the requirements for this technology set the stage for the course. This was followed by two lectures which discussed topics that are basic to all that followed. The capabilities and limitations of computational fluid dynamics to describe these complex flows was addressed; and a review of turbulence models appropriate to compressible flows was presented. A series of generic shock-shock boundary-layer interaction problems which may be viewed as either a means to understand flow physics or as building blocks for vehicle design were presented. How the chemical reactions present in highly hypersonic flows will influence three-dimensional hypersonic flows fields was discussed. For individual titles, see N90-17566 through N90-17573.

N90-17566*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
OPPORTUNITIES FOR IMPROVED UNDERSTANDING OF SUPERSONIC AND HYPERSONIC FLOWS
Robert A. Jones *In* AGARD, Special Course on Three-Dimensional Supersonic/Hypersonic Flows Including Separation Jan. 1990 44 p (For primary document see N90-17565 10-02)
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This overview describes some of the diverse applications which are foreseen in the supersonic and hypersonic regime, and points out both the need and the opportunity for improved understanding of the subject. New facilities and experimental test techniques combined with computational fluid dynamics methods are described to illustrate challenging flows over supersonic wings, separated free-shear mixing layers, and in scramjet-airframe integration.
Author

N90-17567# Technische Hochschule, Aachen (Germany, F.R.). Aerodynamisches Institut.
COMPUTATION OF COMPRESSIBLE VISCOUS FLOWS
D. Haenel *In* AGARD, Special Course on Three-Dimensional Supersonic/Hypersonic Flows Including Separation Jan. 1990 33 p (For primary document see N90-17565 10-02)
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Computational methods for the compressible Navier-Stokes equations are examined with special consideration of hypersonic flows. In the first part the governing equations and relations for equilibrium flow are described, and their basic numerical approaches, in particular for the Euler terms are discussed. As a selected topic the application of the multigrid method to solutions of the Navier-Stokes equations is considered. As a further topic the influence of the numerical damping on the numerical solution of the conservation laws is discussed, and their influence on steady-state, and unsteady solutions of the Navier-Stokes equations is demonstrated. The special numerical problems arising in hypersonic, viscous flows are discussed by means of an upwind relaxation method, and modifications of the scheme to overcome these problems will be presented. Conclusions will be drawn for the specific requirements of hypersonic, viscous flows to the numerical methods.
Author

N90-17568# Office National d'Etudes et de Recherches Aerospatiales, Toulouse (France). Department d'Aerothermodynamique.
TURBULENCE MODELS FOR COMPRESSIVE FLOWS
J. Cousteix and B. Aupoix *In* AGARD, Special Course on Three-Dimensional Supersonic/Hypersonic Flows Including Separation Jan. 1990 53 p (For primary document see N90-17565 10-02)
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The main objective is the presentation and the discussion of turbulence models devoted to calculate aerodynamic flows characterized by high speeds and heat exchanges. The basic equations of the average flow are obtained from the Navier-Stokes equations. After a discussion of various possible ways for defining the averaging process, the equations are written by using the mass-weighted averages. A general background of turbulence models is presented in incompressible flow and several models applied in compressible flow are described. This includes mixing length models, one-equation models, two-equation models and Reynolds stress models. The effects of compressibility and the development of turbulent heat flux equation models are also presented. Finally a few comparisons between computed and experimental data are given.
Author

N90-17569# Calspan-Buffalo Univ. Research Center, NY.
SHOCK-SHOCK BOUNDARY LAYER INTERACTIONS
Michael S. Holden *In* AGARD, Special Course on Three-Dimensional Supersonic/Hypersonic Flows Including Separation 134 p(SEE N90-17565 10-02) Jan. 1990 (For primary document see N90-17565 10-02)
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A study is presented of the aerothermal characteristics of shock/shock boundary layer interactions generated by single and multiple shocks. A review is presented of experimental studies which were conducted over the Mach number range from Mach 2 to 19 in the continuous and short duration test facility. The results of recent experimental studies in which detailed measurements of the distribution of heat transfer and pressure were made for Types 3 and 4 interactions in laminar flows at Mach 6 and 19 are discussed in detail. In these studies measurements at Mach 6 to 19 indicated that the severity of the interaction increased with transition and increasing Mach number, as suggested from simple models. Some Type 4 interactions where maximum heating occurs can also be unstable and, therefore, may be difficult to predict with accuracy. The studies of multiple shock interaction demonstrated that the largest heat loads are generated on the cylinder if the shocks coalesce before they are incident on the cylinder. While the flow fields and aerothermal loads generated by multiple shock impingement provide test cases for code prediction, the peak heating loads are significantly less than for a single shock of the same strength. Because of the low Reynolds numbers at which transition occurs in the free shear layers developed from either single or multiple shock/shock interactions, coupled with the occurrence of flow instabilities for Type 4 interactions, it will be difficult to accurately predict the maximum heating in such flows over a large and important part of the flight regime. However, the major feature of the flow field and pressure distributions were predicted with good accuracy with finite difference and finite element schemes for the solutions of the Navier-Stokes equations.
Author

N90-17570# Technische Univ., Brunswick (Germany, F.R.). Institut fuer Stroemungsmechanik.
AXIAL FLOW IN CORNERS AT SUPERSONIC AND HYPERSONIC SPEEDS
Dietrich Hummel *In* AGARD, Special Course on Three-Dimensional Supersonic/Hypersonic Flows Including Separation Jan. 1990 37 p (For primary document see N90-17565 10-02)

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The intake-type of corner configurations basically formed by two intersecting wedges is treated in a survey. Symmetrical and unsymmetrical wedge/wedge combinations are considered including the limits of plate/plate and wedge/plate configuration. Variations of leading-edge sweep and corner angle are also taken into account. The present knowledge on the supersonic and hypersonic axial flow in such configurations is summarized. On the basis of experimental investigations the structure of the flowfield and the pressure and heat transfer distributions at the surface are analyzed in detail. The effects of various geometric parameters as well as those of Mach number and Reynolds number are described. The status of numerical solutions of the Euler and Navier-Stokes equations for the problem under consideration is also reviewed. Remarkable theoretical results were achieved so far. Some details of the flow structure are still in question and further experimental and theoretical investigations are suggested. Author

N90-17571# Cranfield Inst. of Tech., Bedford (England). Coll. of Aeronautics.

GLANCING SHOCK-BOUNDARY LAYER INTERACTIONS

John L. Stollery *In* AGARD, Special Course on Three-Dimensional Supersonic/Hypersonic Flows Including Separation Jan. 1990 30 p (For primary document see N90-17565 10-02)

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There is no universally agreed definition of glancing interaction but it is usually taken to include those situations where the shock wave generated by one body cuts across the boundary layer growing over another and the intersection line is swept. Such flows are essentially three dimensional and are a sub-set of the many swept interactions. In the simplest glancing interactions the only shock wave of interest is that formed by the shock wave generator. Similarly the only boundary layer of interest is the one affected by shock impingement. The boundary layer development on the shock generator and any shock from the surface supporting the boundary layer are secondary in importance. Thus the more complex corner flows and shock-shock interactions are played in categories of their own and enjoy individual treatment. Just four of the many geometries available will be discussed. These four cover the effects of sweep and bluntness on a fin mounted at right angles to a flat plate. Discussed are sharp unswept fins, sharp swept fins, blunt unswept fins, and blunt swept fins. These models can easily be tested experimentally with the fin mount on a sharp leading edge flat plate or mounted directly from the wall of a wind tunnel test section. However, even with these relatively simple geometries it would be foolish to ignore the mutual interference between the two surfaces. In particular the bow shock generated by a blunt fin will often cause boundary layer separation ahead of the fin root. This in turn generates an oblique shock which interacts with the bow shock so producing an example of the shock-shock interactions treated in detail elsewhere in this course. Similarly, a turbulent boundary layer at the base of a swept blunt fin may trigger leading-edge contamination along the attachment line with consequent increases in heat transfer rate. Hence wherever possible the flow pattern over both the plate and fin surfaces will be investigated. Author

N90-17572# Texas Univ., Austin. Dept. of Aerospace Engineering and Engineering Mechanics.

UNSTEADINESS OF SUPERSONIC AND HYPERSONIC SHOCK INDUCED TURBULENT BOUNDARY LAYER SEPARATION

D. S. Dolling *In* AGARD, Special Course on Three-Dimensional Supersonic/Hypersonic Flows Including Separation Jan. 1990 26 p (For primary document see N90-17565 10-02)

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The unsteadiness of supersonic and hypersonic shock-induced turbulent separated flows is reviewed. Both two-dimensional (2-D) and three-dimensional (3-D) flows are discussed. For organizational reasons, more than physical ones, they are largely discussed in separate sections. The focus in both sections is mainly on the intermittent region, which is the streamwise zone in which the unsteady separation shock moves. The topics discussed include: the qualitative description of the wall pressure signals and unsteady separation process, quantitative aspects of the separation shock wave dynamics and the effects of model geometry and flow conditions, and the mechanisms that were proposed as being the cause of the unsteadiness. Also included, is a brief discussion of the dynamics of the separated flow and the outgoing boundary layer downstream of reattachment. Finally a few remarks are made regarding future work needed to answer some of the many remaining questions. Author

N90-17573*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

REACTING FLOWS

George S. Deiwert and Graham V. Candler *In* AGARD, Special Course on Three-Dimensional Supersonic/Hypersonic Flows Including Separation Jan. 1990 28 p (For primary document see N90-17565 10-02)

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Features of chemically reacting separated hypersonic flows are identified and issues concerning their analysis and simulation are discussed. Emphasis is placed on flows of high temperature dissociating and ionizing air and current methods for studying and characterizing these flows, including separation, are reviewed. The aeroassist orbital transfer vehicle and its flight trajectory are used for illustration. Thermochemical nonequilibrium phenomena are emphasized and extension of continuum analysis to the high altitude slip-flow regime is considered. Author

N90-17574# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

EFFECT OF RIBLETS ON FLOW SEPARATION FROM A CYLINDER AND AN AIRFOIL IN SUBSONIC FLOW M.S. Thesis

Timothy D. Wieck Dec. 1989 86 p
(AD-A216197; AFIT/GAE/ENY/89D-40) Avail: NTIS HC A05/MF A01 CSCL 20/4

This thesis investigated the effect of riblets on flow separation from a cylinder and an airfoil in subsonic flow. Riblets have been used successfully to reduce viscous drag on a flat plate and significantly delay flow separation in a two-dimensional, straight-walled, subsonic diffuser. The investigation indicated that for a 2-D cylinder model, the separation point could be delayed as much as 5.5 percent by applying riblets to the model surface. Minor delays in separation were also achieved by applying riblets to a 2-D airfoil model at 8 and 12 deg angle of attack. Applying riblets to the cylinder and airfoil models consistently altered the pressure distribution compared to the same models without riblets. In comparing the cylinder and airfoil results with those of the subsonic diffuser, it appears that riblets are most effective in delaying flow separation in relatively weak adverse pressure gradients. GRA

N90-17575# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

HYPERSONIC NOZZLE/AFTERBODY PERFORMANCE AT LOW MACH NUMBERS M.S. Thesis

R. Bruce Cochran Dec. 1989 197 p
(AD-A216223; AFIT/GAE/AA/89J-2) Avail: NTIS HC A09/MF A01 CSCL 21/1

The propulsion system for an airbreathing vehicle that operates over a wide Mach number range, subsonic to hypersonic speeds, must be highly integrated into the airframe. The most promising design concept for hypersonic speeds is an airframe-integrated supersonic combustion ramjet (scramjet) which blends aircraft forebody and afterbody functions in combination with the engine (combustors) modules. The low speed performance of a generic

2-D hypersonic nozzle/afterbody configuration was studied experimentally. Wind tunnel tests were conducted at simulated flight Mach numbers of 0.6, 0.8, 1.9, and 3.0, in a Two-Foot Trisonic Gasdynamics Facility (TGF). Parametrics included four cowl configurations and simulated propulsion variations with high pressure, cold (ambient temperature) air. The exhaust flow characteristics, the pressure distributions, pressure coefficients, and pressure drags, were determined. The nozzle/afterbody exhaust flows were overexpanded for all of the configurations and conditions, and produced a pressure drag (thrust loss). The exhaust flow characteristics of the subsonic and supersonic flight Mach numbers were different. The subsonic condition resulted in higher pressure drag levels than for the supersonic conditions. The subsonic pressure drag levels increased with increasing nozzle pressure ratios (NPR), while for the supersonic conditions, the pressure drag levels were nearly constant or decreased with increasing NPR. GRA

N90-17576# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

A COMPUTATIONAL MODEL FOR THICKENING BOUNDARY LAYERS WITH MASS ADDITION FOR HYPERSONIC ENGINE INLET TESTING M.S. Thesis

Robert Douglas Clausen Dec. 1989 87 p
(AD-A216246; AFIT/GAE/ENY/89D-04) Avail: NTIS HC A05/MF A01 CSCL 21/1

The United States Air Force is currently pursuing a national program to develop the technology necessary to build a single staged aircraft capable of flying from conventional runways into orbit. This vehicle, the National Aerospace Plane (NASP), will use airbreathing propulsion to accelerate through hypersonic speeds to orbital velocities. In order to achieve the aerodynamic and propulsive efficiencies necessary to accomplish this goal, the vehicle forebody must be used as a precompression surface for the engine flowpath. This results in a thick boundary layer which must be bled-off or ingested by the engine. A computational model for thickening boundary layers with mass addition is developed. The phenomena of uniform injection into a two-dimensional supersonic stream and subsequent boundary layer growth downstream is discussed. Analysis of the injection region provides the thickness of the boundary layer just aft of injection. An injection region velocity profile is then used to approximate the boundary layer profile just aft of injection and is input into a finite-difference boundary layer code. Downstream profiles and thicknesses are calculated and compared to experimental results. The computational model developed here provides a tool for the design of a boundary layer generation system for hypersonic engine inlet testing. This mass addition system is needed to simulate the boundary layer developed on the forebody of hypersonic vehicles. GRA

N90-17577# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

A WIND TUNNEL STUDY OF A STING-MOUNTED CIRCULATION CONTROL WING M.S. Thesis

John W. Trainor Dec. 1989 86 p
(AD-A216248; AFIT/GAE/ENY/89D-38) Avail: NTIS HC A05/MF A01 CSCL 01/1

This wind tunnel study investigated the feasibility of testing a sting mounted circulation control wing. A 20 percent, 8.5 percent cambered rectangular wing was designed, built, and tested in the AFIT 5-ft wind tunnel. Lift, drag, equivalent drag, and pitching moment coefficients were obtained at Reynolds numbers of 600,000 and 900,000. The force and moment results achieved indicate supercirculation was not present. Flow visualization with nylon tufts displayed extreme flow disruption at the trailing edge, due to free-stream impingement on both the sting and blowing air supply hoses. The available blowing air supply was not strong enough to produce a jet flow with the momentum needed to overcome this disruption. Wing model design changes were recommended to alleviate this problem. GRA

N90-17578# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

EXPERIMENTAL INVESTIGATION TO SUPPRESS FLOW-INDUCED PRESSURE OSCILLATIONS IN OPEN CAVITIES M.S. Thesis

Robert L. Sarno Dec. 1989 119 p
(AD-A216285; AFIT/GAE/ENY/89D-32) Avail: NTIS HC A06/MF A01 CSCL 01/1

High speed tangential flow over open cavities (e.g., aircraft weapon bays) can invoke large pressure oscillations within the cavity. These large oscillations can damage the cavity structure as well as items placed within the cavity. The purpose of this experimental study was to determine the effectiveness of suppressing pressure oscillations by manipulating the shear layer over a two-dimensional cavity with a length-to-depth ratio of two. Two methods, a frequency controllable control surface (fence) and pulsating secondary airflow at the cavity leading edge, were used to manipulate the shear layer. The suppression effectiveness of the fence utilized in both passive and active modes (zero to 120 Hz) was evaluated at six airflow Mach numbers (0.62, 0.76, 0.90, 1.07, 1.28, 1.53). The effectiveness of pulsating secondary airflow was evaluated at one airflow Mach number (1.28) and two flow injection angles (parallel and 45 degrees to the flow) at frequencies ranging from zero to 80 Hz. The effect of steady flow injection was also evaluated at mass flow rates per unit width ranging from 0.323 to 1.27 (lbm/sec/ft). Pressure recordings from within the cavity were made for each test. The effectiveness of a pulsating fence in suppressing the peak mode pressure oscillations proved to be less than that achievable with the fence static. The pulsed secondary flow injection technique was most effective when pulsed at a 45 degree angle to the external flow. GRA

N90-17579# Georgia Inst. of Tech., Atlanta. School of Aerospace Engineering.

NUMERICAL SIMULATION OF SUPERSONIC FREE SHEAR LAYERS Semiannual Progress Report, 1 Jun. - 30 Nov. 1989

L. N. Sankar and I. Tuncer Dec. 1989 19 p
(Contract N00014-89-J-1319)
(AD-A216289) Avail: NTIS HC A02/MF A01 CSCL 20/4

The 3-D supersonic shear layers can asymptotically approach a growth rate equal to 30 percent of that of subsonic shear layers. In an attempt to explain this phenomena, a series of analytical, experimental and computational studies were recently carried out. Many of these studies focused on 2-D supersonic shear layers. In these studies, and in particular, studies based on stability analysis fo 2-D supersonic shear layers, it was found that the shear layer growth rate approaches zero (and not the 30 percent observed originally) as the connective Mach number of the shear layer increased from subsonic and supersonic. Several theories have been proposed to explain the discrepancies between 2-D analysis and 3-D observations. The objective of this research was to study the stability and growth characteristics of 3-D free shear layers through a numerical solution of the 3-D unsteady, compressible Navier-Stokes equations. A general solution procedure was constructed that may be used to study the temporal and spatial growth of 2-D and 3-D waves, to study the effects of random initial disturbances on the shear layer growth and to study the effects of wall on the shear layer growth. This procedure thus complements the well developed techniques of linear stability analysis, and allows one to study additional non-linear phenomena such as saturation of modes, vortex pairing phenomena etc. GRA

N90-17580# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

AN ITERATIVE SOLUTION TO AEROELASTIC EFFECTS IN POTENTIAL FLOW M.S. Thesis

Raymond C. Maple Dec. 1989 101 p
(AD-A216291; AFIT/GAE/ENY/89D-22) Avail: NTIS HC A06/MF A01 CSCL 01/1

The purpose of the study was to develop a method of incorporating static aeroelastic effects into a vortex paneling aerodynamic solution. The study had two basic objectives: Devise

a solution technique and Implement the technique and analyze several test cases. An iterative solution is developed which uses MSC/NASTRAN to perform structural analysis, and a 3-D vortex paneling method to perform aerodynamic analysis. The theory behind the method and details of the implementation are presented. The method is tested for three bodies: a unit aspect ratio rectangular flat plate wing, a rectangular flat plate wing with aspect ratio 6, and a hollow sphere. Results of these tests are used to evaluate both the general performance of the implementation, and the performance for the specific test. The results indicate that the iterative solution method is robust and could potentially be used for solving a variety of aeroelastic problems. Recommendations for further development, evaluation, and use are made. GRA

N90-17650*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
HIGH REYNOLDS NUMBER TESTS OF THE CAST-10-2/DOA 2 TRANSONIC AIRFOIL AT AMBIENT AND CRYOGENIC TEMPERATURE CONDITIONS
E. Stanewsky, F. Demurie (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Goettingen, Germany, F.R.), Edward J. Ray, and C. B. Johnson *In its* CAST-10-2/DOA 2 Airfoil Studies Workshop Results Nov. 1989 p 47-60 (For primary document see N90-17647 10-09)
Avail: NTIS HC A12/MF A02 CSCL 01A

N90-17651*# Institut fuer Theoretische Stroemungsmechanik, Goettingen (Germany, F.R.).
SOME NAVIER-STOKES CALCULATIONS FOR THE CAST-10 AIRFOIL
D. Schwamborn *In* NASA, Langley Research Center, CAST-10-2/DOA 2 Airfoil Studies Workshop Results Nov. 1989 p 61-81 (For primary document see N90-17647 10-09)
Avail: NTIS HC A12/MF A02 CSCL 01A

N90-17652*# Centre d'Etudes et de Recherches, Toulouse (France).
MAIN RESULTS OF CAST-10 AIRFOIL TESTED IN T2 CRYOGENIC WIND TUNNEL
A. Blanchard, A. Seraudie, and J. F. Breil *In* NASA, Langley Research Center, CAST-10-2/DOA 2 Airfoil Studies Workshop Results Nov. 1989 p 83-98 (For primary document see N90-17647 10-09)
Avail: NTIS HC A12/MF A02 CSCL 01A

N90-17653*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
AN EXPERIMENTAL AWTS PROCESS AND COMPARISONS OF ONERA T2 AND 0.3-m TCT AWTS DATA FOR THE ONERA CAST-10 AEROFOIL
Stephen Wolf (Vigyan Research Associates, Inc., Hampton, VA.) and Renaldo Jenkins *In its* CAST-10-2/DOA 2 Airfoil Studies Workshop Results Nov. 1989 p 137-153 (For primary document see N90-17647 10-09)
Avail: NTIS HC A12/MF A02 CSCL 01A

N90-17654*# National Aeronautical Establishment, Ottawa (Ontario).
INVESTIGATION OF CAST-10-2/DOA 2 AIRFOIL IN NAE HIGH REYNOLDS NUMBER TWO-DIMENSIONAL TEST FACILITY
Y. Y. Chan *In* NASA, Langley Research Center, CAST-10-2/DOA 2 Airfoil Studies Workshop Results Nov. 1989 p 155-174 (For primary document see N90-17647 10-09)
Avail: NTIS HC A12/MF A02 CSCL 01A

N90-17657*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
EXPERIENCE WITH SOME REPEAT TESTS ON THE 9 INCH CHORD CAST-10-2/DOA 2 AIRFOIL MODEL IN THE LANGLEY 0.3-m TCT ADAPTIVE WALL TEST SECTION
A. V. Murthy (Vigyan Research Associates, Inc., Hampton, VA.) and Edward J. Ray *In its* CAST-10-2/DOA 2 Airfoil Studies Workshop Results Nov. 1989 p 213-231 (For primary document see N90-17647 10-09)
Avail: NTIS HC A12/MF A02 CSCL 01A

N90-17658*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
COMPARISON OF TWO- AND THREE-DIMENSIONAL NAVIER-STOKES SOLUTIONS WITH NASA EXPERIMENTAL DATA FOR CAST-10 AIRFOIL
R. Charles Swanson, Rolf Radespiel, and V. Edward McCormick (North Carolina State Univ., Raleigh.) *In its* CAST-10-2/DOA 2 Airfoil Studies Workshop Results Nov. 1989 p 233-258 (For primary document see N90-17647 10-09)
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03 AIR TRANSPORTATION AND SAFETY

Includes passenger and cargo air transport operations; and aircraft accidents.

For related information see also *16 Space Transportation* and *85 Urban Technology and Transportation.*

N90-17581# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Propulsion and Energetics Panel.
AIRCRAFT FIRE SAFETY
Oct. 1989 408 p In ENGLISH and FRENCH Symposium held in Sintra, Portugal, 22-26 May 1989
(AGARD-CP-467; ISBN-92-835-0529-8) Copyright Avail: NTIS HC A18/MF A03; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

The Symposium was arranged in the following sessions: Review of Fire-Related Aircraft Accidents; Fire Safety Standards and Research Programmes; Aircraft Internal Fires; Aircraft External Fires; Fire Safety of Military Weapon Systems; Fire Hardening by Advanced Materials and Structural Design; Passenger Behaviour in Emergy Situations; and Passenger Protective Equipment. The Technical Evaluation Report and an Addendum are included at the beginning of the Proceedings. Questions and answers of the discussions follow each paper. The purpose was a review of the present state-of-the-art and of the last improvements. Improvements are listed in the conclusions and recommendations of the Technical Evaluation Report and in the Addendum. For individual titles, see N90-17582 through N90-17619.

N90-17582# Federal Aviation Administration, Atlantic City, NJ. Fire Safety Branch.
INVESTIGATION AND CHARACTERISTICS OF MAJOR FIRE-RELATED ACCIDENTS IN CIVIL AIR TRANSPORTS OVER THE PAST TEN YEARS
Richard G. Hill *In* AGARD, Aircraft Fire Safety Oct. 1989 17 p (For primary document see N90-17581 10-03)
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A number of fire-related accidents and incidents that have occurred during the present decade are summarized. The selection of accidents/incidents was based on information availability and perceived importance of those chosen. A brief summary of accident data for the past ten years is presented. A methodology is shown for logically calculating the effects of cabin fire safety improvements on survivability utilizing past accidents. Eight accidents and four incidents are discussed and their link to safety improvements is described. A call for better information from accident investigations was issued. Author

N90-17583# Cranfield Inst. of Tech., Bedford (England).
AIRCRAFT FIRES: A STUDY OF TRANSPORT ACCIDENTS FROM 1975 TO THE PRESENT
A. F. Taylor *In* AGARD, Aircraft Fire Safety Oct. 1989 19 p (For primary document see N90-17581 10-03)

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A further study is being made, on a world-wide basis, of accident summaries and reports together with recent papers on the various aspects of fire safety. The aim is to compare the period since 1974 with the first twenty years of survivable accidents to turbine powered aircraft as presented to the 1975 AGARD Symposium in Rome. While the study is still far from complete it does seem that, although some lessons were learned and improvements were made or are on the way, crashworthiness, fire, and survival remain areas of major concern. Author

N90-17584# Canadian Aviation Safety Board, Ottawa (Ontario).
AIRCRAFT FIRE SAFETY: LEARNING FROM PAST ACCIDENTS
W. T. Tucker *In* AGARD, Aircraft Fire Safety Oct. 1989 10 p (For primary document see N90-17581 10-03)
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The real value of aviation occurrence investigations lies in the lessons that can be learned from them to eliminate future accidents or reduce their severity. Past accidents are reviewed with emphasis on the Canadian experience (e.g., Pacific Western Airlines B737 at Calgary International Airport in March 1984). The determination of contributing factors and causes and the identification of safety deficiencies as practiced by the Canadian Aviation Safety Board are differentiated. Also included are areas of current concern and topics requiring further research with a view to further improving aircraft fire safety. Author

N90-17585# Federal Aviation Administration, Atlantic City, NJ. Fire Safety Branch.
DEVELOPMENT OF IMPROVED FIRE SAFETY STANDARDS ADOPTED BY THE FEDERAL AVIATION ADMINISTRATION
Constantine P. Sarkos *In* AGARD, Aircraft Fire Safety Oct. 1989 14 p (For primary document see N90-17581 10-03)
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A series of improved fire safety standards for transport aircraft adopted or proposed by the United States Federal Aviation Administration over the past five years are summarized and the technical development of these standards are described. Important test results and analyses employed to develop the new standards are described. Reference is made to technical publications issued by the FAA for each fire safety area. Emphasis is placed on recent and high-impact rulemaking actions such as the heat release standard for large surface area interior panels (based on the Ohio State Rate-of-Heart-Release Apparatus). Other activities summarized include heat resistance evacuation slides, smoke detectors and fire extinguishers, cargo compartment fire protection, seat cushion fire blocking layers, floor proximity lighting, and crewmember protecting breathing equipment. Author

N90-17586# Department of Civil Aviation, An Hoofddorp (Netherlands).
FIRE SAFETY IN CIVIL AVIATION
W. Korenromp *In* AGARD, Aircraft Fire Safety Oct. 1989 12 p (For primary document see N90-17581 10-03)
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A large share of all fatalities in civil aviation are caused by fire. For a passenger who considers traveling by air as just another human activity to spend his lifetime, like walking, sporting or sleeping, the risk of flying is more relevant per time unit than per passenger-kilometer. This approach gives also a partial answer why so much should be done to improve safety in civil aviation and to harden the cabin against fire hazards, although commercial air transportation is already considered to be very safe. It is explained what relations exist between preventive measures and measures that mainly enhance survivability. An overview of types of aircraft accidents is given, which points to what types of measures are applicable and effective. The regulatory authorities should gradually develop the airworthiness requirements along these lines, in concert with technological progress and with an emphasis on quality. This will require much attention for cost-benefit analyses for new as well as old safety measures. Author

N90-17587# Civil Aviation Authority, London (England).
A REVIEW OF UK CIVIL AVIATION FIRE AND CABIN SAFETY RESEARCH
Trevor J. Gilpin *In* AGARD, Aircraft Fire Safety Oct. 1989 4 p (For primary document see N90-17581 10-03)
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A broad overview of current research in the UK into cabin safety is presented with particular emphasis on fire research. The status of passenger protection equipment is reviewed and work in the UK on cabin water sprays is reported. Work on fire blocking layers and small scale tests for the measurement of heat release from aircraft furnishing materials are discussed along with the suppression of fire in cargo compartments. Other topics include work on the mathematical modeling of aircraft cabin fires and on the human factors side, a study of the behavioral aspects of passengers evacuating an aircraft in a competitive situation. Author

N90-17588# Federal Ministry of Transport, Bonn (Germany, F.R.). Directorate General for Civil Aviation and Spaceflight.
OBJECTIVES AND RESULTS OF CABIN FIRE RESEARCH IN GERMANY
Manfred Wittmann *In* AGARD, Aircraft Fire Safety Oct. 1989 6 p (For primary document see N90-17581 10-03)
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German activities in aircraft cabin fire safety started in the early 1980's, highlighted by a full scale test in 1986, simulating an aircraft in-flight fire in a modern widebody fuselage. Beginning with a statistical analysis of in-flight fires in the period 1970 to 1982, efforts are presented from the political side to improve aircraft fire safety and outlines the philosophy why Germany concentrated on in-flight fire research. The consequences drawn out of the studies and test results for the design of aircraft cabin interiors and for post-crash fire situations are described. Finally, a view to future activities, including full scale component tests, is presented. Author

N90-17589# Air Canada, Montreal (Quebec). Materials and Processes Engineering.
NEW AIRCRAFT CABIN AND CARGO FLAMMABILITY STANDARDS FOR TRANSPORT CATEGORY AIRCRAFT
Arthur M. Wittenberg *In* AGARD, Aircraft Fire Safety Oct. 1989 9 p (For primary document see N90-17581 10-03)
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In transport aircraft, passenger safety is of paramount importance in establishment of criteria and requirements covering fireworthiness. Thus for cabin and cargo interiors, regulators and aircraft manufacturers have established flammability standards and/or criteria for materials used in these areas. The aircraft manufacturers in turn furnish aircraft with existing state-of-the-art materials technology which will satisfy or exceed the standards and/or criteria requirements. The evolution of these flammability standards to-date and test methods used to ascertain compliance, and an indication of the materials used to meet these standards are outlined. Author

N90-17590# Lufthansa German Airlines, Frankfurt (Germany, F.R.). Cabin, Cargo Systems.

FIRE PREVENTION IN TRANSPORT AIRPLANE PASSENGER CABINS

Udo Wargenau *In* AGARD, Aircraft Fire Safety Oct. 1989 6 p (For primary document see N90-17581 10-03)

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The most important aspect in air transportation is safety, a part of which is fire prevention. In the environment of the passenger cabin there are different ways to prevent fires. The most obvious one is to provide adequate detection and extinguishing devices. The second way is to design in a fire-preventive manner. The third and most challenging way is to be concerned with fire-resistant materials of the latest state of the art. Although airplanes are designed and built by big airframe manufacturers the airline engineers can take some influence on a fire-hard cabin. Aside from continually requesting changes from aircraft manufactuers the engineers can force the interior equipment vendors to use advanced techniques and materials. This, however, requires a certain degree of know-how and the good intention to assist these vendors. Author

N90-17591# Federal Aviation Administration, Atlantic City, NJ. Fire Safety Branch.

CHARACTERISTICS OF TRANSPORT, AIRCRAFT FIRES MEASURED BY FULL-SCALE TESTS

Constantine P. Sarkos and Richard G. Hill *In* AGARD, Aircraft Fire Safety Oct. 1989 19 p (For primary document see N90-17581 10-03)

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Full-scale transport aircraft cabin fire tests conducted in the United States under postcrash fire conditions are discussed. The logic behind the development of fire test scenarios is described, including a comparison of fire involvement by external fuel fire penetration through an opening or by fuselage burnthrough. Early full-scale tests in the 1960's and 1970's that furnished data on the characteristics of cabin fires are briefly described. Past test activities addressing facets of the fuselage burnthrough problem are also discussed. The impact of environmental factors (such as wind, door opening configuration, and fuselage orientation) on fire penetration through openings and the resulting cabin hazards is discussed on the basis of past test activities. The majority of the data presented are from a recent full-scale test to determine fire/hazard progression in a postcrash cabin fire environment with emphasis on post-flashover conditions, to examine factors affecting occupant survivability, and to evaluate the performance of a protective breathing equipment filter. Past studies addressing important cabin fire characteristics and concepts, such as flashover, stratification, and survivability are discussed and cited. Author

N90-17592# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Cologne (Germany, F.R.). Inst. fuer Antriebstechnik.

FULL SCALE STUDY OF A CABIN FIRE IN AN A300 FUSELAGE SECTION

R. Dussa, R. Fiala, R. Wagner, and B. Zenses *In* AGARD, Aircraft Fire Safety Oct. 1989 16 p (For primary document see N90-17581 10-03)

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Aircraft accidents involving cabin fires have shown that the burning behavior of the cabin materials plays a vital role for the survivability of the passengers. To gain more information on the complex physical and chemical processes in a cabin fire and one the validity of laboratory test methods to evaluate the burning behavior a Cabin-Fire-Safety program was set up. Besides laboratory tests a first full scale cabin fire test was carried out in the scope of this program. For this test an 18 meter long section of a wide body jet was available. Six meters of this fuselage were furnished with cabin materials fulfilling the newest safety standards. In this section gas sampling tubes, thermocouples, radiometers, and smoke density measuring devices were installed. Additionally, the fire was observed and recorded by five video cameras. The burner was situated between the side wall of the cabin and the adjacent seat of the last seat row. After a burning time of 105 seconds a self sustaining fire had developed. The burner was shut off. The fire was extinguished after 365 seconds. Halon was used as an extinguishing agent. Total halon consumption: 1.000 kg. A optical inspection of the cabin had the following result: The seat cushions showed minor to medium burns, except those in the immediate vicinity of the ignition source. The overall weight loss of the seat cushions was approximately 10 percent. The carpet was nearly undamaged. All other parts, as side wall panels, ceiling panels, insulation, air conditioning system, hatracks and so on suffered heavy damage or were destroyed. From gas concentration and temperature readings one could conclude that in the first 60 seconds after ignition survivable conditions prevailed in the cabin. In the following 60 seconds gas concentrations and temperatures reached lethal values. Oxygen concentration decreased rapidly. Visibility fell to zero. Flash-over occurred. The test will be illustrated by video film. Author

N90-17593# Civil Aviation Authority, Gatwick (England). Safety Regulation Group.

AIRCRAFT INTERNAL FIRES

Reginald D. Halliday *In* AGARD, Aircraft Fire Safety Oct. 1989 9 p (For primary document see N90-17581 10-03)

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With modern day appliances and equipment a well trained fire service unit should be able to effectively deal with any external fire that may occur at a survivable aircraft accident situation. Incidents that have occurred during recent years show that a positive approach is still needed to what is loosely referred to as the internal fire. New legislation does call for higher fire resistance standards but there will always be the requirement for fire service personnel to deal with this type of problem. A number of attempts were made to address this problem by using various methods to inject either water or halon gas. While these attempts are a possible way forward they have inherent problems. The fire service are faced with a situation over which they have no control and cannot alter in any way. These are: response time, the possible need to deal with an external fire first, passengers evacuating and using exits and denying access or exits that were left open by escaping passengers and will allow any exterior fire to enter. At the present time the United Kingdom is testing a system that does address these problems. It is really two systems in one: onboard water to be used through the cabin area at very low consumption rates activated immediately on impact; and the ability for external services to connect to the system without entering the fuselage and thereby maintain the water sprays while evacuation continues or rescue actions take place. Author

N90-17594# Factory Mutual Research Corp., Norwood, MA.

IGNITABILITY OF JET-A FUEL VAPORS IN AIRCRAFT FUEL TANKS

Erdem A. Ural, Robert G. Zaloosh, and Franco Tamanini *In* AGARD, Aircraft Fire Safety Oct. 1989 13 p (For primary document see N90-17581 10-03)

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Ignitability criteria for fuel vapors in aircraft wing tanks were analyzed. The effects of ambient temperature, tank pressurization, and ventilation on the flammability of the ullage gas mixtures were demonstrated using the ULLAGE computer code. It was shown that in the absence of tank inerting, flammable mixtures are most likely to form at some point during all transport and fighter missions considered. The relative ignitability of ullage vapor mixtures versus the propane-air mixture called for in Military Standard 1757A was

analyzed for a lightning strike scenario, for spark ignition and hot surface ignition modes. It was shown that the military standard is not always a conservative evaluation of the ullage ignition hazard. A procedure to determine when the ullage is more readily ignitable than the mixture specified by the Military Standard 1757A was recommended. Author

N90-17595*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
FIRE SAFETY APPLICATIONS FOR SPACECRAFT
Robert Friedman and Sandra I. Olson *In* AGARD, Aircraft Fire Safety Oct. 1989 15 p Previously announced as N89-24413 (For primary document see N90-17581 10-03)
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Fire safety for spacecraft is reviewed by first describing current practices, many of which are adapted directly from aircraft. Then, current analyses and experimental knowledge in low-gravity combustion, with implications for fire safety are discussed. In orbiting spacecraft, the detection and suppression of flames are strongly affected by the large reduction in buoyant flows under low gravity. Generally, combustion intensity is reduced in low gravity. There are some notable exceptions, however, one example being the strong enhancement of flames by low-velocity ventilation flows in space. Finally, the future requirements in fire safety, particularly the needs of long-duration space stations in fire prevention, detection, extinguishment, and atmospheric control are examined. The goal of spacecraft fire-safety investigations is the establishment of trade-offs that promote maximum safety without hampering the useful human and scientific activities in space. Author

N90-17596# Fire Research Station, Borehamwood (England).
FIRE SCIENCE AND AIRCRAFT SAFETY
G. Cox and J. B. Moss (Cranfield Inst. of Tech., Bedford, England) *In* AGARD, Aircraft Fire Safety Oct. 1989 12 p (For primary document see N90-17581 10-03)
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The increased awareness of fire hazards in both passenger transport and buildings has precipitated a reappraisal of models of fire spread embracing both empirical and more fundamentally-based computational approaches. Recent developments are described in the fire science-related aspects of such hazards, contrasting the broad strategies adopted with those applied in the more highly developed combustion technologies. It seeks to demonstrate how current capabilities and future developments, particularly in the computational modeling fire, and driven primarily by the study of fires in building enclosures, might be utilized to guide layout, design and the selection of furnishing materials in aircraft cabins. Examples of current capabilities of computational fluid dynamic models in describing such critical fire phenomena as smoke movement, fire growth, and flame spread are presented. Author

N90-17597# Thames Polytechnic, London (England). Centre for Numerical Modelling and Process Analysis.
FORCED AND NATURAL VENTING OF AIRCRAFT CABIN FIRES: A NUMERICAL SIMULATION
E. R. Galea and N. C. Markatos *In* AGARD, Aircraft Fire Safety Oct. 1989 9 p Prepared in cooperation with National Technical Univ., Athens (Greece) (For primary document see N90-17581 10-03)
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A steady-state three-dimensional mathematical field model describing aircraft cabin fires is presented. The fire is modeled by a simple heat source. The simulation is intended to represent nonspreading fires. The computer code uses a Body-Fitted Co-ordinate (BFC) formulation to model accurately the interior of the aircraft that is neither Cartesian nor polar-cylindrical. The dimensions of the fuselage are that of a BOEING-737. The effect of various openings in the fuselage on the temperature distribution within the empty aircraft cabin are investigated. With the cabin fitted with seats, ceiling panels and overhead stowage bins the effect of the aircrafts air-conditioning system on the temperature distribution within the burning fuselage is also examined. Early results suggest that a reverse flow situation (i.e., cold air injected through floor vents and hot air sucked out at ceiling vents) greatly reduces the temperature throughout the fuselage. Author

N90-17598# New Brunswick Univ., Fredericton. Dept. of Mechanical Engineering.
TIME DEVELOPMENT OF CONVECTION FLOW PATTERNS IN AIRCRAFT CABINS UNDER POST-CRASH FIRE EXPOSURE
G. V. Hadjisophocleous, A. C. M. Sousa, and J. E. E. Venart *In* AGARD, Aircraft Fire Safety Oct. 1989 14 p (For primary document see N90-17581 10-03)
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The internal transient thermal response of an aircraft cabin to pool fires of different strengths burning outside an open door or fuselage break is simulated. The thermal processes within the cabin are modeled using the fluid flow and energy governing equations. Particular attention is given to the level and time development of the thermal stratification within the cabin over the first 90 s and the time allowed for evacuation of passengers in aircraft certification tests. The numerical simulations for a two-dimensional domain were carried out with advanced numerical techniques based on a control volume formulation combined with boundary-fitted coordinates. Assessments conducted previously on the reliability and accuracy of the algorithm are also briefly outlined. Author

N90-17599# Societe Bertin et Cie, Les Milles (France). Electronics and Information Div.
VULCAIN: AN EXPERT SYSTEM DEDICATED TO FIRE RISK ANALYSIS WITHIN COMPLEX INDUSTRIAL ENVIRONMENTS
Serge Galant, Pierre Mereau, and N. Turin *In* AGARD, Aircraft Fire Safety Oct. 1989 9 p (For primary document see N90-17581 10-03)
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VULCAIN is an expert system which allows rapid fire risk analysis within complex industrial environments. It works step by step as a function of the risk critically. It uses: as a first step, a risk analysis using standards; then more complete diagnosis based on various aspects which are not covered by standards (viz: fire propagation on targets, influence of both natural and forced ventilation); and finally, complete spatial and temporal numerical simulations of fire propagation where temperatures vs time diagrams are obtained to characterize fire propagation and/or extinction. VULCAIN is very convivial software tool to carry out complex sensitivity analysis concerning all critical parameters (combustible material, openings, wall thermal and chemical characteristics) and systematic studies concerning a given criterion (for instance: possibility of fire control by human means). All the knowledge base within VULCAIN was validated with respect to small and full scale experiments. Good results were obtained for such industrial sites as: nuclear power plants, storage areas, submarines. Its use can be envisaged for vulnerability studies of airplanes. Author

N90-17600# Air Force Aero Propulsion Lab., Wright-Patterson AFB, OH.
HOT SURFACE IGNITION STUDIES OF AVIATION FLUIDS
R. G. Clodfelter *In* AGARD, Aircraft Fire Safety Oct. 1989 8 p (For primary document see N90-17581 10-03)
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Hot surface ignition temperature testing was performed in the Aircraft Engine Nacelle Fire Test Simulator (AENFTS) located at Wright-Patterson Air Force Base, Ohio. The objective of this test program was to measure Minimum Hot Surface Ignition Temperatures (MHSIT) of five common aircraft fluids (MIL-H-5606 and MIL-H-83282 hydraulic fluids, JP-4 and JP-8 fuels and MIL-L-7808 lubricating oil) using an air-heated bleed-air duct in a high realism test article. A simulated portion of the F-16 engine compartment and F100 engine was inserted into the AENFTS and the five aircraft fluids were injected as spray or drips (streams) onto various locations on the hot bleed-air duct. Ventilation air pressure, temperature, velocity and the flammable fluid flow rate were varied to study their effect on the MHSIT of these fluids. The results show that MHSIT is dependent on both fluid application mode, spray or drip, and application location. MHSIT increased for all test conditions as ventilation air pressure decreased. Increasing ventilation air temperature tended to decrease the MHSIT. Although MHSIT increased with ventilation air velocity increases, this is not a dependable safety criteria since stagnation regions are known to exist in engine compartments. In general, due to the high level of simulation achieved in this program and the wide scope of the test conditions, the results will be of significant value in the fire safety design of future aircraft systems. Author

N90-17601# Royal Aerospace Establishment, Farnborough (England).
THE STABILITY OF FUEL FIRES
J. R. Tilston *In* AGARD, Aircraft Fire Safety Oct. 1989 11 p (For primary document see N90-17581 10-03)
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The mechanisms of ignition, stabilization, and propagation of aviation turbine fuel fires are examined and discussed in the context of aircraft accidents. This appraisal suggests that the crucial role of a suitably sized aerodynamic stability zone in the stablization of fuel spray fires was not adequately recognized in the past. It also suggests that the importance of hot surfaces as sources of fuel preparation and ignition was, similarly, neglected. From considerations of the buoyancy and radiative characteristics of even moderately sized pool fires it is concluded that great care is required in the interpretation of results from smaller experimental fires. Author

N90-17602# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.).
ONBOARD FIRE- AND EXPLOSION SUPPRESSION FOR FIGHTER AIRCRAFT
J. Wordehoff *In* AGARD, Aircraft Fire Safety Oct. 1989 11 p (For primary document see N90-17581 10-03)
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The threats to which modern fighter aircraft can be exposed and the state of the art hardware for active and passive fire and explosion suppression systems on the market to combat these threats are described. A summary of forecasted development will be given especially in the field of fire detection systems. An example is given to indicate the progress which was achieved in weight reduction and system improvement over the last 10 years. A fire and explosion suppression system layout will be given for a modern fighter aircraft including its penalty on mass and fuel denial. Author

N90-17603# Naval Air Systems Command, Washington, DC. Subsystems Branch.
US NAVY AIRCRAFT FIRE PROTECTION TECHNOLOGY
P. Weinberg *In* AGARD, Aircraft Fire Safety Oct. 1989 7 p (For primary document see N90-17581 10-03)
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The U.S. Navy aircraft are routinely exposed to various combat and non-combat threats that could cause either a fire or fuel system explosion. An overview is provided for the design concepts to prevent, detect, and extinguish these fires and explosions. Examples are given of actual designs and equipment installed on current Navy aircraft. An assessment is included on how well these systems perform under test and operational conditions. Author

N90-17604# National Defence Headquarters, Ottawa (Ontario). Accident Investigation Prevention.
AIRCRAFT FIRE SAFETY IN THE CANADIAN FORCES
T. A. Bailey *In* AGARD, Aircraft Fire Safety Oct. 1989 6 p (For primary document see N90-17581 10-03)
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Flight safety is a prime consideration of the Canadian Forces in its approach to air operations. The aim of the flight safety program is to prevent the accidental loss of aviation resources and this is done by investigation of occurrences, determination of cause, and implementation of preventive measures. Aircraft fire safety is a concern not only to save lives, but resources as well. An overview of aircraft fire safety in the Canadian Forces and how fire safety is approached for the various aircraft types is presented. The transport, maritime, and helicopter fleets are discussed as are procedures for the CF-18. Another aspect of fire safety is that is briefly covered is the crash, fire, and rescue capability (CFR) at military airports to handle an emergency. Author

N90-17605# Boeing Commercial Airplane Co., Seattle, WA.
FIRE HARDENING OF AIRCRAFT THROUGH UPGRADES OF MATERIALS AND DESIGNS
J. M. Peterson, J. C. McMillan, and J. T. Likes *In* AGARD, Aircraft Fire Safety Oct. 1989 7 p (For primary document see N90-17581 10-03)
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Commercial air transportation is the safest mode of transport, because the industry and its regulators have emphasized accident avoidance along with backup fire management/control and personnel evacuation strategies when accidents do occur. Regulatory authorities set the minimum safety standards for the design, manufacture, and operation of aircraft, to which the individual manufacturers and operators add their own unilateral, self-imposed safety criteria. The evolution and status of the FAA regulatory fire safety criteria applicable to aircraft manufacturers, and the additional criteria imposed by the manufacturers on themselves such as D6-51377 for Boeing and ATS 1000.001 for AIRBUS Industries, are discussed. Author

N90-17606# British Aerospace Public Ltd. Co., Woodford (England). Airlines Div.
FIRE HARDENING OF AN AIRCRAFT PASSENGER CABIN
G. J. Treloar *In* AGARD, Aircraft Fire Safety Oct. 1989 9 p (For primary document see N90-17581 10-03)
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The implications of fires to that part of a passenger aircraft comprising the fuselage pressure shell are discussed, with particular reference to the passenger cabin and crew areas. The history of materials utilization is reviewed, leading to an overview of the current materials scenario, with particular reference to the use of combustible materials. The particular materials related regulations, covering aspects of fire hardening appertaining to baggage holds, passenger cabin furnishings, and seats, and the additional smoke and toxicity tests introduced by constructors, are discussed. Potential developments to fire harden the fuselage shell to resist an external fire, and cabin furnishings improvements to provide increased fire hardening are exemplified. The interaction between

the design aims of the constructors, passenger acceptance, the requirements of the airlines and fire safety are presented finally.
Author

N90-17607# Royal Air Force Coll., Cranwell (England).
FIRE RESISTANCE AND BREAKDOWN OF COMPOSITE MATERIALS
K. W. Smith *In* AGARD, Aircraft Fire Safety Oct. 1989 4 p (For primary document see N90-17581 10-03)
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Aspects of cabin fire safety and passenger protective breathing equipment are considered. The use of non-metallic composites in furnishings and structures is examined for advantages and future trends. Test requirements for fire resistance and breakdown are reviewed and suggestions are made in light of past accident experience.
B.G.

N90-17608# Messerschmitt-Boelkow-Blohm G.m.b.H., Bremen (Germany, F.R.). Non-Metallic Materials and Processes.
ADVANCED MATERIALS FOR INTERIOR AND EQUIPMENT RELATED TO FIRE SAFETY IN AVIATION
Hans-Dieter Berg *In* AGARD, Aircraft Fire Safety Oct. 1989 7 p (For primary document see N90-17581 10-03)
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The improvements of product safety is continuously under review by aircraft manufacturers. One of the most important fields of safety for passengers and crew members relates to improvements in connection with fires inside and outside the cabin. Naturally, several paths have to be followed simultaneously to achieve the best possible effect. First and foremost there is obviously the endeavor to avoid such accidents from the start. The training of the crew, design of the aircraft and maintenance, airport safety facilities and, last not least, the introduction of improved materials are of vital importance to reduce the danger of accidents with fires. The important aspect of material development and structural design for the interior furnishings and equipment of aircraft is considered.
Author

N90-17609# Aerospatiale, Toulouse (France).
NEW MATERIALS FOR CIVIL AIRCRAFT FURNISHING
M. J. Frustie and C. Kuras (Aerospatiale, Suresnes, France) *In* AGARD, Aircraft Fire Safety Oct. 1989 4 p (For primary document see N90-17581 10-03)
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In order to improve aircraft safety with respect to fire, in the last few years the authorities have issued several regulations relative to the fire resistance of organic materials used in civil aircraft commercial furnishing, in particular FAR 25 Amendment 61 and FAR 121 Amendment 189. The purpose is to limit the heat release of the materials used for passenger cabin furnishing. These regulations to be applied on aircraft delivered as soon as August 88 are very severe as they prohibit the use of most of the materials which were used up to now. The purpose is to present the various investigations on new materials made at Aerospatiale together with the development of new technologies.
Author

N90-17610# National Research Council of Canada, Ottawa (Ontario). Inst. for Research in Construction.
HEAT RELEASE RATE MEASUREMENT FOR EVALUATING THE FLAMMABILITY OF AIRCRAFT MATERIALS
Yoshio Tsuchiya *In* AGARD, Aircraft Fire Safety Oct. 1989 8 p (For primary document see N90-17581 10-03)
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With the goal of improving fire safety in passenger aircraft, the FAA and Transport Canada have adopted a new test method to evaluate the flammability of aircraft interior materials. The method uses a modified ASTM E906 release rate test apparatus. Experiments have shown that the test is affected by small variations in such factors as the pattern of airflow in the combustion chamber, the number and position of pilot flames and certain characteristics of the sample such as flame retardancy and physical construction. The various factors affecting the test are discussed. Of particular interest is a comparison between the thermal method and the oxygen consumption method of HRR measurement. The oxygen consumption method is recommended.
Author

N90-17611# Factory Mutual Research Corp., Norwood, MA.
FLAMMABILITY TESTING OF AIRCRAFT CABIN MATERIALS
A. Tewarson and R. G. Zalosh *In* AGARD, Aircraft Fire Safety Oct. 1989 12 p (For primary document see N90-17581 10-03)
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Before the new Federal Aviation Administration flammability regulations for aircraft cabin materials were announced, various laboratory flammability tests were conducted on generic aircraft panel materials. Besides convective heat release rates and smoke optical densities, which are included in the new regulations, the tests included material ignitability, fire propagation rates, chemical heat release rates, and toxic gas generation rates. Data obtained using different test methods often differ significantly for the same generic panel material. For example, critical heat fluxes for ignition as measured in the NIST Ignition Apparatus are 16percent to 110 percent higher than those measured in the FMRC apparatus. In the case of fire propagation, test data are reported for electrical cables as well as panel materials. The cable fire propagation rates are correlated against a fire propagation index based on heat release rate and ignitability data. These data may be useful in assessing the in-flight fire hazard of various cabin materials. In the case of heat release rates per unit surface area, if data from different test facilities are normalized by incident heat flux and compared in terms of the ratio of chemical, and convective heats of combustion to the effective heat of gasification, there is agreement to within at least one significant figure for most materials. Aircraft panel material smoke generation potential, as measured by mass optical density, is shown to be highly dependent on the light source and the ventilation conditions in the fire test. Since these conditions differ substantially for post-crash fires and in-flight fires, flammability guidelines for smoke generation, toxicity, and corrosivity during in-flight fires may entail different test methods than currently used to screen cabin materials for post-crash fire survivability.
Author

N90-17612# Rouen Univ. (France). Lab. de Toxicologie.
METHOD FOR THE EVALUATION OF TOXICITY OF COMBUSTION PRODUCTS FROM AIRCRAFT CABIN MATERIALS: ANALYSIS AND RESULTS [METHODE D'EVALUATION DE LA TOXICITE DES PRODUITS DE THERMOLYSE DES MATERIAUX DE CABINE AVION ANALYSE DES RESULTATS] **c52**
J. M. Jouany and M. Favand (Centre d'Essais Aeronautique Toulouse, France) *In* AGARD, Aircraft Fire Safety Oct. 1989 8 p In FRENCH (For primary document see N90-17581 10-03)
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In order to aid in the selection of aircraft cabin materials, an experimental method was developed for the evaluation of toxic decomposition products from burning materials. The complete methodology combines a fire model and an experimental procedure that permits, on the one hand, an assessment of the material combustion reaction in terms of physico-chemical factors (weight loss, flammability, heat emission, and emission of fumes) and, on the other hand, an analysis of combustion product toxicity in terms of biological factors measured in mice (incapacitation and mortality).

Methods for the statistical multivariate analysis of the collected data (principal components analysis) are discussed and a technique for the classification of materials is proposed. Transl. by M.G.

N90-17613# Cranfield Inst. of Tech., Bedford (England). Applied Psychology Unit.
PASSENGER BEHAVIOUR IN AIRCRAFT EMERGENCIES INVOLVING SMOKE AND FIRE **c53**
Claire Harrison and Helen Muir *In* AGARD, Aircraft Fire Safety Oct. 1989 14 p (For primary document see N90-17581 10-03)
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A review of the accident literature has indicated that in aircraft emergencies involving smoke and fire both environmental and behavioral factors will influence passenger survival rates. These factors include the number of operational exits, the presence of toxic fumes, the extent to which anxiety, disorientation, feelings of depersonalization, panic, and behavioral inaction occur among the passengers. Furthermore, in situations in which life is placed under severe threat, in addition to the experience of fear, people will compete with each other in order to survive. As a consequence the orderly process of evacuation for which passengers are briefed, frequently breaks down and the behavior of passengers appears to be confused and disorderly. In an experimental program, a series of evacuation exercises were performed, in which incentive payments were made in order to introduce the element of competition which is known to lead to a disorderly evacuation in some aircraft accidents. Using this technique six configurations at the vestibule prior the type 1 exits, and seven seating configurations adjacent to the overwing exit were investigated. Author

N90-17614# Air Transport Users Committee, London (England). Air Transport Users Committee.
SMOKEHOODS DONNED QUICKLY. THE IMPACT OF DONNING SMOKEHOODS ON EVACUATION TIMES **c54**
J. H. B. Van *In* AGARD, Aircraft Fire Safety Oct. 1989 12 p (For primary document see N90-17581 10-03)
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Seven hundred and sixty-five volunteers aged between 18 and 50 took part in 9 simulated emergency evacuations in clear air and smoke with and without ventilated smoke hoods. Analysis of differences between the experimental conditions, age, sex, seat location, exit, and test run showed that the key factor was seat location. While the wearing of hoods and the presence of smoke both increased the evacuation times the interaction between these separate factors was negative, indicating that the use of hoods in the presence of smoke was less than the sum of the additional times attributable to smoke and hood. A quadratic response surface model enabled the evacuation time for each seat to be predicted for each condition and show that evacuation time increases with the distance from an exit and the aisle. It was concluded that the wearing of smoke hoods should not significantly impede the ability of passengers to evacuate an aircraft cabin in an emergency. Author

N90-17615# Lufthansa German Airlines, Frankfurt (Germany, F.R.). Emergency Training.
FLIGHT CREW TRAINING FOR FIRE FIGHTING **c53**
Ernst-Albrecht Limley *In* AGARD, Aircraft Fire Safety Oct. 1989 6 p (For primary document see N90-17581 10-03)
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A description is contained of Lufthansa emergency training aspects for flight-and cabin crews in respect to fire fighting. It addresses topics as preventive measures, on board fire fighting equipment, measures in case of an on board fire, training for actual fire fighting, and future developments. Author

N90-17616# Civil Aeromedical Inst., Oklahoma City, OK. Protection and Survival Lab.
THE RESEARCH PROGRAM AT THE CIVIL AEROMEDICAL INSTITUTE CONCERNING PROTECTIVE BREATHING EQUIPMENT FOR USE BY CREW AND PASSENGERS IN AN AVIATION SMOKE/FUME ENVIRONMENT **c54**
E. Arnold Higgins *In* AGARD, Aircraft Fire Safety Oct. 1989 7 p (For primary document see N90-17581 10-03)
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On June 3, 1987, a final rule defining Crew Protective Breathing Equipment (CPBE) was issued by the FAA. On September 1, 1987, Action Notice A-8150.2 (Guidelines for Approval of Crewmember Protective Breathing Equipment) established requirements and tests for certifying CPBE. The recommended method for testing contaminant leakage proved unsatisfactory when chemically-generated oxygen was used. The Civil Aeromedical Institute (CAMI) developed a new method, and has tested two candidate devices. This test method is discussed. Recent interest in reviewing the feasibility of providing passenger protective breathing equipment (PPBE) was stimulated, in part, by the British Airtours B0737 accident at Manchester, England, in August 1985. In October, 1986, the airworthiness authorities at Great Britain, France, Canada, and the United States initiated a coordinated effort to reevaluate PPBE. A history of CAMI involvement in the study of PPBE will be presented, as will the status of current activities in this program. Author

N90-17617# Royal Air Force Inst. of Pathology and Tropical Medicine, Aylesbury (England).
THE INVESTIGATION OF PARTICULATE MATTER IN THE LUNGS OF SMOKE INHALATION DEATH VICTIMS **c52**
I. R. Hill and B. P. Michelson *In* AGARD, Aircraft Fire Safety Oct. 1989 9 p (For primary document see N90-17581 10-03)
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Although the mechanisms involved in the causation of injury and death, due to the inhalation of the products of combustion are incompletely understood, the potential hazard is well recognized and was, at least in part, for many year. The response to smoke and toxic fume inhalation are many and varied, and include airway obstruction, bronchitis, atalectasis, pneumonitis, and respiratory failture. Damage to the cilia in the upper respiratory tract and to respiratory macrophages, may cause changes in the pulmonary defence mechanisms, which may in turn predispose to lung infection. The Manchester Airport Boeing 737 accident in 1985, and subsequently a series of domestic fires, have refocusod lay interest in the various hazards. Insofar as house fires are concerned, 30 people died when soft furnishings were the first item ignited in 1962; 20 years later 152 people died. Research workers in various countries have long expressed an interest in this problem and there was considerable expenditure of effort and resources, in attempts to fully understand the mechanisms involved. Unfortunately contrary views still persist and this has its effects upon attempts to understand mechanisms and to propose logical solutions, which will improve the safety of the environment in fires. The literature and the results of some microscopical studies of the victims of fires investigated in an attempt to explain some of the observed phenomena. Author

N90-17618# Royal Albert Edward Infirmary, Wigan (England).
THE IMPORTANCE OF PATHOPHYSIOLOGICAL PARAMETERS IN FIRE MODELLING OF AIRCRAFT ACCIDENTS **c52**
John S. S. Stewart *In* AGARD, Aircraft Fire Safety Oct. 1989 12 p (For primary document see N90-17581 10-03)
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The importance of pathophysiological parameters in fire modeling of aircraft accidents was under estimated. Pathological

and toxicological studies and survivors' evidence all indicate rapid incapacitation by kerosene smoke. A combination of anoxic and stagnant anoxia can explain the evidence. Incapacitation by smoke is the important event which leads to death from cyanide and carbon monoxide poisoning. Fire blocking and fire hardening, although useful in some limited situations, are largely irrelevant to real accidents involving fatalities. Fire models which purport to establish a safety benefit, on the sole basis of escape time to flashover, are far too simplistic. Much more weight should be given to protective breathing equipmemt and to water spray systems. Author

N90-17619# Huntingdon Research Centre Ltd. (England).
MODELLING TIME TO INCAPACITATION AND DEATH FROM TOXIC AND PHYSICAL HAZARDS IN AIRCRAFT FIRES c52
David A. Purser *In* AGARD, Aircraft Fire Safety Oct. 1989 13 p (For primary document see N90-17581 10-03)
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Studies of incapacitation and lethality in laboratory animals and human fire victims, resulting from exposure to thermal decomposition products from many materials, indicate two main mechanisms of toxicity, narcosis (asphyxia) and irritancy. Narcotic effects are caused by the common asphyxiant gases, CO, HCN, low O2, and CO2 and can be predicted to a reasonable degree with existing knowledge. Irritant effects are caused by a variety of combustion products some of which are unknown, but can be quantified from small scale rodent combustion toxicity tests in terms of the mass loss concentration of combustion products using an index of respiratory tract irritation, and an index of lethality, in mg/min/liter. A mathematical model is presented for estimating toxic and physical hazard in fire in terms of time to incapacitation or death. The model takes the concentration/time profiles of the above products, smoke optical density, temperature and radiant heat flux (derived from other mathematical models of aircraft fires or large scale fire tests) and calculates time to incapacitation using a Fractional Effective Dose method based upon the known toxic effects to the combustion products, and of the physical hazards, in man, primates and rodents. Author

N90-17620*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
ANALYSIS OF THE NATIONAL TRANSONIC FACILITY MISHAP
Edwin L. Fasanella (Lockheed Engineering and Sciences Co., Hampton, VA.) and Martha P. Robinson Jan. 1990 15 p
(NASA-TM-101686; NAS 1.15:101686) Avail: NTIS HC A03/MF A01 CSCL 14B

The nonlinear dynamic finite element code DYnamic Crash Analysis of STructures (DYCAST) was used to model an accident scenario that occurred at the National Transonic Facility (NTF) wind tunnel. A post mishap investigation revealed that a total of five upstream bulkhead fairing plates were missing, three in one location and two in another. These plates were drawn into the wind tunnel's composite fan blades causing extensive damage. A DYCAST model was developed to determine if one-half of a small thermal shield flange clamp, weighing approximately 2.7 lbs., could have spun off the NTF drive shaft and impacted the bulkhead fairing plates with sufficient energy to cause failure of the attachment bolts. The clamp was presumed to have spun off at a tangent from the NTF drive shaft at a velocity of 1624 in/sec (drive shaft rotating at 580 rpm). The DYCAST analytical model predicts that impact of the 2.7 lbs projectile failed all of the bolts in two of the fairing plates allowing them to escape from the bulkhead ring with a low velocity of a few in/sec. Author

N90-17621# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
DEVELOPMENT OF AN AUTOMATIC GROUND COLLISION AVOIDANCE SYSTEM USING A DIGITAL TERRAIN DATABASE M.S. Thesis
Gregory W. Bice Dec. 1989 152 p
(AD-A216247; AFIT/GAE/ENY/89D-03) Avail: NTIS HC A08/MF A01 CSCL 01/2

Several ground collision avoidance systems (GCAS) have been developed to warn the pilot of a potential collision with the terrain if some action is not taken. All current systems have shortcomings pertaining to the sensors that are used and the recovery maneuver that is flown. The USAF is evaluating the potential of digital terrain databases for onboard navigation and terrain avoidance in combat aircraft. The purpose of this thesis was to develop a control system for performing terrain avoidance using a simulated terrain database. This study was conducted for an F-16 aircraft in level flight at 0.6 Mach and sea level conditions. A state-space model of the aircraft and its flight control system was developed using aircraft control derivatives, an F-16 control law diagram, and traditional linearization techniques on the aircraft equations of motion. A control system for implementing terrain avoidance was derived based on the look-ahead capability of the terrain database. Control system response was evaluated using a simulated terrain obstacle and various look-ahead distances on the terrain database. Results indicated that a 1200 foot, or roughly 1.8 second, look-ahead distance provided good improvement in terrain avoidance capabilities for the F-16 compared to looking strictly downward from the aircraft for terrain information. GRA

04 AIRCRAFT COMMUNICATIONS AND NAVIGATION

Includes digital and voice communication with aircraft; air navigation systems (satellite and ground based); and air traffic control.

For related information see also *17 Space Communications, Spacecraft Communications, Command and Tracking* and *Communications and Radar.*

N90-17622# Naval Postgraduate School, Monterey, CA. Dept. of Computer Science.
A COMPUTER SIMULATION STUDY OF A SENSOR-BASED HEURISTIC NAVIGATION FOR THREE-DIMENSIONAL HOUGH TERRAIN WITH OBSTACLES M.S. Thesis
Do Kyeong Ok Jun. 1989 123 p
(AD-A215115) Avail: NTIS HC A06/MF A01 CSCL 17/7

A search strategy for autonomous vehicle navigation over three-dimensional digitized terrain containing obstacles is presented and studied in this thesis. The vehicle possesses no a priori information about terrain. Using only information obtained through a sensor which has a limited sensing range, the vehicle navigates a goal utilizing heuristics adopted from human behavior. Simulation results produce a near-optimal path solution in a very short time. Simulation results also prove that this strategy is suitable for real-time navigation under dynamically changing or unknown environments. GRA

N90-17623# Federal Aviation Administration, Atlantic City, NJ.
LORAN C MONITOR: FACILITIES CENTRAL PROCESSING UNIT (FCPU) PORT EVALUATION
Frank Garufi Mar. 1990 24 p Sponsored by FAA, Washington, DC
(DOT/FAA/CT-TN89/57) Avail: NTIS HC A03/MF A01

The purpose was to facilitate the development of software for the Loran C Monitor Facilities Central Processing Unit (FCPU) board. The objective was to verify that the Loran C Monitor files and data structures for the FCPU port of the Monitor agreed with the Loran C Monitor/FCPU Interface Control Document (ICD) Revision A of June 6, 1989. All Monitor files were accessible through the FCPU port. The archive data file structures were not as indicated in the ICD but could be accessed using methods described in this report. The link initialization protocol, error detection, and error recovery procedures were not functional at the time of integration testing. This did not prevent data transfer or command execution over the FCPU port but full validation of

Monitor functions through the FCPU port was not possible.
Author

N90-17624# Spectra Research Systems, Inc., Solana Beach, CA.
SOUTH PACIFIC OMEGA VALIDATION ANALYSIS Final Report, Aug. 1988 - Aug. 1989
Verne E. Hildebrand Aug. 1989 268 p
(Contract N00123-86-D-0134)
(AD-A215916) Avail: NTIS HC A12/MF A01 CSCL 17/7

This report, the sixth in the Omega Validation series assesses the Omega Very Low Frequency radio navigation system performance in the South Pacific Ocean area. Our general overview describes: (1) a new emphasis for this and following validations on establishing signal quality through characterizing zones of signal-self-interference, (2) validation planning, (3) measurements and (4) analysis undertaken. Regions of self interference due to equatorial zone propagation are predicted, and analyzed for each Omega signal. Zones of signal interference caused by propagation the long way around the world (long-path) are predicted and assessed. Navigation accuracy and signal coverage is assessed. For most of the validation region Omega fully meets navigation expectations. The prediction guidance in the form Propagation Phase Corrections, zones of poor signal quality (Modal and Long-Path), and Station Coverage are largely correct. A relatively small but significant zone assessed. Confirmation however, was essentially circumstantial because no data was available within or close to the predicted zone. GRA

N90-17625# Maryland Univ., College Park. Dept. of Physics and Astronomy.
DEVELOPMENT OF A SUPERCONDUCTING SIX-AXIS ACCELEROMETER Final Report, 1 Apr. 1985 - 31 Mar. 1988
Ho Jung Paik, Joel W. Parke, and Edgar R. Canavan Jul. 1989 110 p
(Contract F19628-85-K-0042)
(AD-A215948; GL-TR-89-0181) Avail: NTIS HC A06/MF A01 CSCL 17/7

This report describes research on the superconducting six-axis accelerometer. The theory of a superconducting six-axis accelerometer is discussed, and the construction and test of the accelerometer are also given. The accelerometer was invented to monitor the platform motions of a superconducting gravity gradiometer which is under development at the University of Maryland for space application. The signals from the accelerometer will be used to control the position and the attitude of the gradiometer platform. The superconducting six-axis accelerometer represents by itself a complete inertial navigation system. Integrated with the superconducting gravity gradiometer, it becomes a gradiometer-aided inertial navigation system. GRA

N90-17626# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
DECISION-ANALYTIC APPROACH TO RULE-BASED EXPERT SYSTEM DEVELOPMENT USING GPS (GLOBAL POSITIONING SYSTEM) AS THE MODEL M.S. Thesis
Grady Narvell Elliott, Jr. Dec. 1989 146 p
(AD-A216179; AFIT/GSO/ENS/89D-5) Avail: NTIS HC A07/MF A01 CSCL 17/7

The applicability of using a decision theory approach towards reasoning in expert systems is presented. Particular emphasis is placed on the management of uncertainty and how it can be consistently factored into decision making. Using a PC-based Scheme program as a decision-analytic reasoner, and a Quattro generated file composed of user provided likelihoods as the knowledge base, this capability is demonstrated using an anomalous condition onboard the GPS satellite as the test scenario. The model, using Jeffrey's Rule as a manner of manipulating uncertainty, is able to effectively capture GPS system knowledge probabilistically in a manner that matches expectations of the experts as well as coincides with the GPS Orbital Operations Handbook. How rules are represented in this type of system is discussed as well as the assumptions which go into the model's application. Limitations of the system and recommendations for expanding its uses are also given. GRA

05 AIRCRAFT DESIGN, TESTING AND PERFORMANCE

Includes aircraft simulation technology.

For related information see also *18 Spacecraft Design, Testing and Performance* and *39 Structural Mechanics*.For land transportation vehicles see *85 Urban Technology and Transportation*.

N90-17627*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
SIMULATED-AIRLINE-SERVICE FLIGHT TESTS OF LAMINAR-FLOW CONTROL WITH PERFORATED-SURFACE SUCTION SYSTEM
Dal V. Maddalon and Albert L. Braslow (Analytical Services and Materials, Inc., Hampton, VA.) Washington Mar. 1990 40 p
(NASA-TP-2966; L-16589; NAS 1.60:2966) Avail: NTIS HC A03/MF A01 CSCL 01C

The effectiveness and practicality of candidate leading edge systems for suction laminar flow control transport airplanes were investigated in a flight test program utilizing a modified JetStar airplane. The leading edge region imposes the most severe conditions on systems required for any type of laminar flow control. Tests of the leading edge systems, therefore, provided definitive results as to the feasibility of active laminar flow control on airplanes. The test airplane was operated under commercial transport operating procedures from various commercial airports and at various seasons of the year. Author

N90-17628# Aeronautical Research Labs., Melbourne (Australia).
AN EXAMINATION OF THE FATIGUE METER RECORDS FROM THE RAAF ORION P-3C FLEET Aircraft Structures Technical Memorandum
Douglas J. Sherman Apr. 1989 43 p
(AD-A214000; ARL-STRUC-TM-505; DODA-AR-005-602) Avail: NTIS HC A03/MF A01 CSCL 01/3

Load spectra for the Australian fleet of Orion P-3C aircraft are presented and compared with the ESDU 69023 (discrete gust) and the U.S. MILSPEC A-8861A (power spectral) model, which are here called the baseline models. The turbulence experienced when flying over the sea is about one half of that predicted by the baseline models. The sea appears to reduce the turbulence by a greater amount, and to higher altitudes than indicated by the ESDU model. Transit flights, which involve flying at relatively high altitude over Australia, are about five times as severe as predicted by the baseline models. This supports other observations of a higher than normal incidence of the altitude turbulence (25,000 ft and above) over Australia. GRA

N90-17629# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Systems and Logistics.
REDUCING C130E HERCULES OPERATING COSTS IN THE ROYAL AUSTRALIAN AIR FORCE AND THE UNITED STATES AIR FORCE BY INCREASING CRUISE SPEEDS M.S. Thesis
Dennis G. Green Sep. 1989 189 p
(AD-A215747; AFIT/GLM/ENY/89S-25) Avail: NTIS HC A09/MF A01 CSCL 01/2

The purpose of this research study was to examine a proposal to reduce C130E Hercules operating costs in the Royal Australian Air Force (RAAF) and the United States Air Force (USAF) by increasing cruise speeds. The current fuel conservation policies in the RAAF and USAF do not consider the effect of the policy on aircraft operating costs. RAAF C130E cost data were found to be invalid. The study quantified major differences in the depot servicing, contract servicing, and in-house servicing for RAAF C130E and C130H Hercules aircraft. The study suggests that the RAAF should improve the accuracy of C130E cost data to allow

a valid assessment of the operating costs over the aircraft life cycle. The variable maintenance costs were found to be more than double the hourly fuel costs. Flight Manual data and mission profile data were used to show that the USAF could save $94,613 to $1,979,227(U.S.) in 1989 by flying selected missions at 290 knots instead of 280 knots true airspeed (TAS). The sensitivity of the calculated savings to changes in fuel and maintenance prices was also examined. The study concludes that USAF C130E operating costs can be reduced by increasing cruise speeds. The study recommends that the USAF introduce 290 knots TAS cruise procedures immediately because of the reduction in operating costs and because there are no implementation costs. GRA

N90-17630# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Systems and Logistics.
THE TECHNOLOGY CHALLENGE OF THE ADVANCED TACTICAL FIGHTER: A STUDY OF THE TECHNOLOGY TRANSITION PROCESS M.S. Thesis
Robert J. Gummere Sep. 1989 148 p
(AD-A216109; AFIT/GSM/LSM/89S-13) Avail: NTIS HC A07/MF A01 CSCL 01/3

This study examined the technology transition process at the Aeronautical System Division between the Wright Research and Development Center (WRDC), and the Advanced Tactical Fighter Systems Program Office (ATF SPO) at Wright Patterson AFB OH. Four groups were surveyed, they included: WRDC, ATF SPO, ASD engineering, and defense contractors. Five Investigative Questions guided the research: (1) how has the operating command contributed in the development and transition of technology; (2) how well have the official and unofficial technology transition processes worked as perceived by laboratory, SPO, EN, and contractor personnel; (3) what organizations are considered important sources of information on new technology, and what is the frequency of contact with those organizations; (4) what influence is the contractor perceived to have on the success or failure of moving technology from WRDC to the ATF SPO; and (5) is the perceived risk of new technology by the SPO a significant barrier in the transition process. GRA

N90-17631# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Systems and Logistics.
COST EFFECTIVENESS OF COMPOSITE MATERIALS ON THE F-15 AND F-16 AIRCRAFTS M.S. Thesis
Diana M. Bock Sep. 1989 97 p
(AD-A216353; AFIT/GCA/LSY/89S-3) Avail: NTIS HC A05/MF A01 CSCL 05/3

This thesis sought to determine the cost effectiveness of composite materials by determining the significant cost drivers in a cost estimating model. Based on a review of historical literature and interviews, it was originally suspected that composite materials were not as cost effective as metal structures in terms of maintenance man-hours. The models developed in this project revealed that number of landings, flight hours, and sortie counts were the most significant cost drivers for maintaining the F-4 stabilator system, a metal structure, and the composite materials found on the horizontal and vertical stabilizers of the F-15 and F-16 aircrafts. The stabilator system on the F-4 was most respondent to the three cost drivers, as this structure required significantly more maintenance man-hours than either the F-15 or F-16 parts. The F-16 horizontal stabilizer assembly was also sensitive to the cost drivers found, as this composite part had more maintenance man-hours than the other three composite parts. The F-16 skins, vertical stabilizer assembly and the F-15 torque box, horizontal stabilator assembly showed that regardless of the number of landings, flight hours, or sortie counts, the maintenance man-hours remained constant, within the range of data for this project. GRA

N90-17552 ARMCON, Inc., Shalimar, FL.
THE INTEGRATION OF STORES ON MODERN TACTICAL AIRCRAFT: WHERE WE HAVE BEEN, AND WHAT WE SHOULD DO FOR THE FUTURE
Charles S. Epstein *In* Nielsen Engineering and Research, Inc., Missile Aerodynamics: NEAR Conference on Missile Aerodynamics 1989 23 p (For primary document see N90-17540 10-02)
Copyright Avail: Issuing Activity

N90-17554 Dornier-Werke G.m.b.H., Friedrichshafen (Germany, F.R.).
DYNAMIC DERIVATIVES OF MISSILES AND FIGHTER-TYPE CONFIGURATIONS AT HIGH ANGLES OF ATTACK
Heinz Fuchs *In* Nielsen Engineering and Research, Inc., Missile Aerodynamics: NEAR Conference on Missile Aerodynamics 1989 21 p (For primary document see N90-17540 10-02)
Copyright Avail: Issuing Activity

06 AIRCRAFT INSTRUMENTATION

Includes cockpit and cabin display devices; and flight instruments.

For related information see also *19 Spacecraft Instrumentation* and *35 Instrumentation and Photography.*

N90-17632*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
A HEAD UP DISPLAY FORMAT FOR APPLICATION TO V/STOL AIRCRAFT APPROACH AND LANDING
Vernon K. Merrick, Glenn G. Farris, and Andrejs A. Vanags (SYRE Corp., Moffett Field, CA.) Jan. 1990 76 p
(NASA-TM-102216; A-89215; NAS 1.15:102216) Avail: NTIS HC A05/MF A01 CSCL 01D

A head up display (HUD) format developed at NASA Ames Research Center to provide pilots of V/STOL aircraft with complete flight guidance and control information for category-3C terminal-area flight operations, is described in detail. These flight operations cover a large spectrum, from STOL operations on land-based runways to VTOL operations on small ships in high seas. Included in this description is a complete geometrical specification of the HUD elements and their drive laws. The principal features of this display format are the integration of the flightpath and pursuit guidance information into a narrow field of view, easily assimilated by the pilot with a single glance, and the superposition of vertical and horizontal situation information. The display is a derivative of a successful design developed for conventional transport aircraft. The design is the outcome of many piloted simulations conducted over a four-year period. Whereas the concepts on which the display format rests could not be fully exploited because of field-of-view restrictions, and some reservations remain about the acceptability of superimposing vertical and horizontal situation information, the design successfully fulfilled its intended objectives. Author

07 AIRCRAFT PROPULSION AND POWER

Includes prime propulsion systems and systems components, e.g., gas turbine engines and compressors; and onboard auxilliary power plants for aircraft.

For related information see also *20 Spacecraft Propulsion and Power, 28 Propellants and Fuels,* and *44 Energy Production and Conversion.*

N90-17633*# Illinois Univ., Urbana-Champaign. Coordinated Science Lab.
TRANSIENT FAULT BEHAVIOR IN A MICROPROCESSOR: A CASE STUDY
Patrick Duba Nov. 1989 38 p
(Grant NAG1-602)
(NASA-CR-186240; NAS 1.26:186240; UILU-ENG-89-2240; CSG-116) Avail: NTIS HC A03/MF A01 CSCL 21E

An experimental analysis is described which studies the susceptibility of a microprocessor based jet engine controller to upsets caused by current and voltage transients. A design automation environment which allows the run time injection of

transients and the tracing from their impact device to the pin level is described. The resulting error data are categorized by the charge levels of the injected transients by location and by their potential to cause logic upsets, latched errors, and pin errors. The results show a 3 picoCouloumb threshold, below which the transients have little impact. An Arithmetic and Logic Unit transient is most likely to result in logic upsets and pin errors (i.e., impact the external environment). The transients in the countdown unit are potentially serious since they can result in latched errors, thus causing latent faults. Suggestions to protect the processor against these errors, by incorporating internal error detection and transient suppression techniques, are also made. Author

N90-17634# Cambridge Univ. (England). Dept. of Engineering.
A METHOD FOR THE PREDICTION OF SUPERSONIC COMPRESSOR BLADE PERFORMANCE
C. Freeman (Rolls-Royce Ltd., Derby, England) and N. A. Cumpsty 1989 35 p Presented at the 34th ASME International Gas Turbine and Aeroengine Congress and Exposition
(CUED/A-Turbo/TR-126; Rept-89-GT-326; ISSN-0309-6521)
Avail: NTIS HC A03/MF A01

A simple model is used to calculate the flow in compressor blades with supersonic relative inlet flow. The method addresses the common irreversible deceleration and compression which takes place when a shock stands ahead of the blade leading edge. It does not attempt to describe the process when inverse camber in the forward part is used to decelerate the flow before the shock. The one-dimensional model utilizes the conservation of stagnation enthalpy, mass flow and momentum in the inlet region. The momentum equation is applied in the direction parallel to the blade surface at inlet and one of the fundamental simplification adopted is that the projected area of the blades gives such a small force in this direction that a very simple approximation for it suffices. The model is able to predict the loss creation in the inlet region. The level of calculated loss agree well with measured values when the Mach numbers are sufficiently high for the inlet loss to dominate. Furthermore, the correct trends of loss with incidence and blade speed are predicted. The pressure rise and flow can also be predicted when the correct deviation and meridional streamtube convergence are given. The method predicts trends usually seen in measurements: the narrowing of the useful operating range between choke and flow instability (surge) as blade speed is increased and a steepening of the surge line at the higher speeds. Author

N90-17635*# Sverdrup Technology, Inc., Cleveland, OH.
VISCOUS THREE-DIMENSIONAL ANALYSES FOR NOZZLES FOR HYPERSONIC PROPULSION Final Report
G. J. Harloff, D. R. Reddy, and H. T. Lai Jan. 1990 25 p Proposed for presentation at the AGARD Symposium on Combined Cycle Propulsion for Hypersonic Application, Madrid, Spain, 21-25 May 1990
(Contracts NAS3-24105; NAS3-25266)
(NASA-CR-185197; E-5267; NAS 1.26:185197) Avail: NTIS HC A03/MF A01 CSCL 21E

A Navier-Stokes computer code was validated using a number of two- and three-dimensional configurations for both laminar and turbulent flows. The validation data covers a range of freestream Mach numbers from 3 to 14, includes wall pressures, velocity profiles, and skin friction. Nozzle flow fields computed for a generic scramjet nozzle from Mach 3 to 20, wall pressures, wall skin friction values, heat transfer values, and overall performance are presented. In addition, three-dimensional solutions obtained for two asymmetric, single expansion ramp nozzles at a pressure ratio of 10 consists of the internal expansion region in the converging/diverging sections and the external supersonic exhaust in a quiescent ambient environment. The fundamental characteristics that were captured successfully include expansion fans; Mach wave reflections; mixing layers; and nonsymmetrical, multiple inviscid cell, supersonic exhausts. Comparison with experimental data for wall pressure distributions at the center planes shows good agreement. Author

N90-17636*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
LOW NO(x) POTENTIAL OF GAS TURBINE ENGINES
Robert R. Tacina 1990 20 p Presented at the 28th Aerospace Sciences Meeting, Reno, NV, 8-11 Jan. 1990; sponsored by AIAA
(NASA-TM-102452; E-5237; NAS 1.15:102452; AIAA-90-0550)
Avail: NTIS HC A03/MF A01 CSCL 21E

The purpose is to correlate emission levels of gas turbine engines. The predictions of NO(x) emissions are based on a review of the literature of previous low NO(x) combustor programs and analytical chemical kinetic calculations. Concepts included in the literature review consisted of lean-premixed-prevaporized (LPP), rich burn/quick quench/lean burn (RQL), and direct injection. The NO(x) emissions were found to be an exponential function of adiabatic combustion temperature over a wide range of inlet temperatures, pressures and (lean) fuel-air ratios. A simple correlation of NO(x) formation with time was not found. The LPP and direct injection (using gaseous fuels) concepts have the lowest NO(x) emissions of the three concepts. The RQL data has higher values of NO(x) than the LPP concept, probably due to the stoichiometric temperatures and NO(x) production that occur during the quench step. Improvements in the quick quench step could reduce the NO(x) emissions to the LPP levels. The low NO(x) potential of LPP is offset by the operational disadvantages of its narrow stability limits and its susceptibility to autoignition/flashback. The Rich-Burn/Quick-Quench/Lean-Burn (RQL) and the direct injection concepts have the advantage of wider stability limits comparable to conventional combustors. Author

N90-17637# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
TURBULENCE SCALE EFFECTS ON HEAT TRANSFER IN A LINEAR TURBINE CASCADE M.S. Thesis
Lello Galassi Dec. 1989 272 p
(AD-A216222; AFIT/GAE/ENY/89D-11) Avail: NTIS HC A12/MF A01 CSCL 20/13

Heat transfer for a turbine cascade is examined for turbulence scale effects. The turbulence integral scale and microscale lengths of the free-stream flow are controlled by air-jet injection through a grid placed in the free-stream flow. Air is injected into the flow in three primary directions: co-flow, cross-flow, and counter-flow, at several injection pressures. Results are obtained for heat transfer on the blade without the jet-grid in the free-stream flow. Surface pressures on the turbine blade are examined for three injection directions. Surface heat transfer on the blade and turbulence intensity and turbulence scale results are obtained for two grid locations, three air injection orientations, and three injection orifice diameters over a range of injection pressures. Turbulence integral scale and microscale lengths are measured in two free-stream flow coordinates. Results show the integral scale length is primarily dependent on the diameter of the jet-grid tube, but may be controlled to a lesser degree by changing the orientation of the jet-grid injection to a co-flow or counter-flow direction; or by changing the secondary air-jet injection pressure. The turbulence microscale is primarily dependent on the location of the jet-grid within the flow, but, to a lesser degree, controlled by the orientation of the jet-grid injection, jet orifice diameter, and injection pressure. GRA

N90-17638*# General Electric Co., Cincinnati, OH. Aircraft Engine Business Group.
ALTITUDE TESTING OF THE 2D V/STOL ADEN DEMONSTRATOR ON AN F404 ENGINE Final Report
J. T. Blozy Feb. 1985 110 p
(Contract NAS3-23042)
(NASA-CR-174824; NAS 1.26:174824) Avail: NTIS HC A06/MF A01 CSCL 21E

The Augmented Deflector Exhaust Nozzle (ADEN) exhaust system was tested in the PSL-3 altitude chamber at the NASA Lewis Research Center in order to evaluate aerodynamic performance, cooling-system effectiveness, and mechanical operation at flight-type conditions. The ADEN, a flight-weight, two-dimensional, thrust-vectoring nozzle, was successfully tested

on the F404 engine using a remote engine control system for automatic or manual setting of the throat-area control and available fan air for the nozzle internal cooling system. Throughout the test, the ADEN performed with no adverse effects on the engine or augmentor operation. R.J.F.

08 AIRCRAFT STABILITY AND CONTROL

Includes aircraft handling qualities; piloting; flight controls; and autopilots.

For related information see also *05 Aircraft Design, Testing and Performance.*

N90-17639*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
LONGITUDINAL STABILITY AND CONTROL CHARACTERISTICS OF THE QUIET SHORT-HAUL RESEARCH AIRCRAFT (QSRA)
Jack D. Stephenson and Gordon H. Hardy Washington Dec. 1989 43 p
(NASA-TP-2965; A-89133; NAS 1.60:2965) Avail: NTIS HC A03/MF A01 CSCL 01C

Flight experiments were conducted to evaluate various aerodynamic characteristics of the Quiet Short-Haul Research Aircraft (QSRA), an experimental aircraft that makes use of the upper-surface blown (USB) powered-lift concept. Time-history records from maneuvers performed with the aircraft in landing-approach and take-off configurations (with its stability augmentation system disengaged) were analyzed to obtain longitudinal stability and control derivatives and performance characteristics. The experiments included measuring the aircraft responses to variations in the deflection of direct-lift control spoilers and to thrust variations as well as to elevator inputs. The majority of the results are given for the aircraft in a landing configuration with the USB flaps at 50 degrees. For this configuration, if the static longitudinal stability is defined as the variation of the pitching-moment coefficient with the lift coefficient at a constant thrust coefficient, this stability decreases significantly with increasing angle of attack above 9 degrees. For this configuration, at small and negative angles of attack and high levels of thrust, the elevators and the horizontal stabilizer lost effectiveness owing to incipent stalling, but this occurred only during unsteady maneuvers and for brief time intervals. Author

N90-17640# National Aerospace Lab., Tokyo (Japan).
DEVELOPMENT OF THE TRIPLEX DIGITAL FLIGHT CONTROL SYSTEM OF THE STOL RESEARCH AIRCRAFT ASKA
Feb. 1989 96 p In JAPANESE; ENGLISH summary
(NAL-TR-1013; ISSN-0389-4010) Avail: NTIS HC A05/MF A01

National Aerospace Laboratory has been developing the STOL research aircraft named ASKA which underwent its maiden flight on October 26th, 1985. This project was started for the purpose of establishing STOL technology in Japan. In order to improve the stability and control of the ASKA in the low air speed region, the ASKA has a triplex digital stability and control augmentation system (SCAS) in which new technologies are introduced. Given here are an outline of design objectives, functions, a series of development tests, and results of the SCAS which include triplex digital computer systems, a triplex force summing electro hydraulic series servo actuator, a head-up display, and a low airspeed sensor. Most of the development tests were devoted to verifying the system hardware and software through control system functional mockup tests, and flight simulator tests connecting with the digital computer systems. The overall functions of the SCAS were tested in actual flight and the problems encountered during these tests are also presented. Author

N90-17641*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
EQUATIONS OF MOTION OF SLUNG LOAD SYSTEMS WITH RESULTS FOR DUAL LIFT
Luigi S. Cicolani and Gerd Kanning Feb. 1990 40 p
(NASA-TM-102246; A-89270; NAS 1.15:102246) Avail: NTIS HC A03/MF A01 CSCL 01C

General simulation equations are derived for the rigid body motion of slung load systems. These systems are viewed as consisting of several rigid bodies connected by straight-line cables or links. The suspension can be assumed to be elastic or inelastic, both cases being of interest in simulation and control studies. Equations for the general system are obtained via D'Alembert's principle and the introduction of generalized velocity coordinates. Three forms are obtained. Two of these generalize previous case-specific results for single helicopter systems with elastic or inelastic suspensions. The third is a new formulation for inelastic suspensions. It is derived from the elastic suspension equations by choosing the generalized coordinates so as to separate motion due to cable stretching from motion with invariant cable lengths. The result is computationally more efficient than the conventional formulation, and is readily integrated with the elastic suspension formulation and readily applied to the complex dual lift and multilift systems. Equations are derived for dual lift systems. Three proposed suspension arrangements can be integrated in a single equation set. The equations are given in terms of the natural vectors and matrices of three-dimensional rigid body mechanics and are tractable for both analysis and programming. Author

N90-17642 Cincinnati Univ., OH.
DIRECT MULTIVARIABLE ADAPTIVE CONTROLLER WITH APPLICATION TO WING FLUTTER Ph.D. Thesis
Rafael Livneh 1989 269 p
Avail: Univ. Microfilms Order No. DA9003255

The problem of designing a robust simplified adaptive controller for the control of a wing flutter vibration is studied. The Direct Multivariable Model Reference Adaptive Control (DMMRAC) algorithm developed in Bar-Kana et al. is extended to include independent excitations to both the input and output of the plant. Those excitations are partitioned into measurable and unmeasurable parts and are incorporated into the ideal trajectory and into the adaptive law. The stability of the adaptive law is proved by using ultimate boundedness results for non-autonomous systems. The property of Almost Strict Positive Realness is thoroughly examined and related to the concepts of collocated sensors and actuators, stable transmission zeros, output stabilizability and the solution of the steady state Riccati equation. The numerical simulations of the wing control problem demonstrates stability and robustness over a wide range of variations in the simulation parameters. Dissert. Abstr.

N90-17643# Army Aviation Research and Development Command, Fort Eustis, VA. Aviation Applied Technology Directorate.
FORCE DETERMINATION SENSITIVITIES STUDY FOR FULL-SCALE HELICOPTER GROUND VIBRATION TESTING Memorandum Report
Nick Calapodas and Keith Hoff Sep. 1989 63 p
(AD-A215983; AD-F800086; USAAVSCOM-TM-89-D-4) Avail: NTIS HC A04/MF A01 CSCL 01/3

A fundamental objective of the Army's research and development efforts is to increase the reliability of the Army's airmobility force, which consists primarily of rotary-wing aircraft. Excessive vibrations have always been a problem for helicopters due to the vibratory airloads generated by the main rotor as it moves edgewise through the air. Maintenance and part replacement costs require that potential vibration problems be diagnosed as early as possible in the helicopter development and fielding cycle. A methodology known as Force Determination which was developed in the early 1970's is applicable to early diagnosis of vibration-induced problems. The objective of this program was to evaluate the limitations and accuracy of the Force Determination method. Controlled laboratory experiments and numerous sensitivity studies were performed to assess the validity of this method. GRA

N90-17644# Army Aviation Research and Development Command, Fort Eustis, VA. Aviation Applied Technology Directorate.
THE ADVANCED DIGITAL-OPTICAL CONTROL SYSTEM (ADOCS) USER DEMONSTRATION PROGRAM Final Report, Apr. - Sep. 1987
Joel L. Terry, Jr., Joseph D. Dickinson, and Gary D. Jerauld Sep. 1989 44 p
(Contract DAAK51-82-C-0002; DA Proj. 1L1-63211-D-436)
(AD-A215984; AD-F800085; USAAVSCOM-TM-89-D-2) Avail: NTIS HC A03/MF A01 CSCL 17/7

This report documents the guest/user pilot assessment of the Advanced Digital-Optical Control System (ADOCS) installed in the JUH-60A Light Hawk helicopter. The assessment was performed by 76 guest/user pilots from government, industry, and the news media. Pilot comments were collected on the performance of the ADOCS fly-by-light control system relative to the Primary Flight Control System (PFCS), The Automatic Flight Control System (AFCS) (Core and Selectable modes), and the force-type sidearm controllers. Several areas for improvements were identified. GRA

N90-17645# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
DESIGN OF A ROBUST CONTROLLER FOR AN UNSTABLE NONMINIMUM PHASE GUIDED MISSILE M.S. Thesis
Randall L. Riddle Dec. 1989 196 p
(AD-A216147; AFIT/GAE/ENY/89D-29) Avail: NTIS HC A09/MF A02 CSCL 16/2

H2 and H at infinity design techniques are applied to a state space representation of a surface to air missile system with unstable nonminimum phase airframe response characteristics. A method for converting the tracking and command following problems to the standard problem is given. Artificial frequency-dependent filtering of external inputs is required for proper closed loop system performance, and a method for deriving the filters is developed. Areas requiring further study are identified. GRA

N90-17646# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
STABILITY CHARACTERISTICS OF A COMBAT AIRCRAFT WITH CONTROL SURFACE FAILURE M.S. Thesis
Stephen M. Zaiser Nov. 1989 147 p
(AD-A216196; AFIT/GAE/ENY/89D-42) Avail: NTIS HC A07/MF A01 CSCL 01/1

In this thesis, an investigation of the stability characteristics of an aircraft which has sustained damage to a primary control surface was performed. The analysis was performed using wind tunnel data taken on an F-16 model in a test. The coupled, non-linear, aircraft equilibrium equations for constant altitude, rectilinear flight were derived. The aircraft stability and control derivatives were developed and analyzed to identify aerodynamic coupling with implications for an aircraft with failed control surface(s). Three control schemes which allow for progressively greater independence among the control surfaces were formulated for use in the evaluation of an aircraft with an actuator failure of the rudder. The investigations were conducted at two flight conditions representative of the aircraft at cruise and landing approach velocities. Regions in alpha/beta space where equilibrium is obtainable were investigated to identify remaining control authority, drag characteristics, and aircraft orientation. The matrix decomposition techniques of Singular Value Decomposition and the Row Reduced Echelon Form of the augmented matrix were used to provide additional insight into the interrelationship of the control surfaces at different points within the defined trim region. GRA

N90-17551 Aerospatiale, Chatillon (France). Div. Engins Tactiques.
THE USE OF LATERAL JET CONTROL AT AEROSPATIALE
R. G. Lacau and M. Robert *In* Nielsen Engineering and Research, Inc., Missile Aerodynamics: NEAR Conference on Missile Aerodynamics 1989 16 p (For primary document see N90-17540 10-02)
Copyright Avail: Issuing Activity

09 RESEARCH AND SUPPORT FACILITIES (AIR)

Includes airports, hangars and runways; aircraft repair and overhaul facilities; wind tunnels; shock tubes; and aircraft engine test stands.

For related information see also *14 Ground Support Systems and Facilities (Space).*

N90-17647*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
CAST-10-2/DOA 2 AIRFOIL STUDIES WORKSHOP RESULTS
Edward J. Ray, comp. and Acquilla S. Hill, comp. Washington Nov. 1989 259 p Workshop held in Hampton, VA, 23-27 Sep. 1988
(NASA-CP-3052; L-16633; NAS 1.55:3052) Avail: NTIS HC A12/MF A02 CSCL 14B

During the period of September 23 through 27, 1988, the Transonic Aerodynamics Division at the Langely Research Center hosted an International Workshop on CAST-10-2/DOA 2 Airfoil Studies. The CAST-10 studies were the outgrowth of several cooperative study agreements among the NASA, the NAE of Canada, the DLR of West Germany, and the ONERA of France. Both theoretical and experimental CAST-10 airfoil results that were obtained form an extensive series of tests and studies, were reviewed. These results provided an opportunity to make direct comparisons of adaptive wall test section (AWTS) results from the NASA 0.3-meter Transonic Cryogenic Tunnel and ONERA T-2 AWTS facilities with conventional ventilated wall wind tunnel results from the Canadian high Reynolds number two-dimensional test facility. Individual papers presented during the workshop are included. For individual titles, see N90-17648 through N90-17658.

N90-17648*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
NONLINEAR TRANSONIC WALL-INTERFERENCE ASSESSMENT/CORRECTION (WIAC) PROCEDURES AND APPLICATION TO CAST-10 AIRFOIL RESULTS FROM THE NASA 0.3-M TCT 8- BY 24-INCH SLOTTED WALL TEST SECTION (SWTS)
Clyde R. Gumbert, Lawrence L. Green, and Perry A. Newman *In its* CAST-10-2/DOA 2 Airfoil Studies Workshop Results Nov. 1989 p 9-35 (For primary document see N90-17647 10-09)
Avail: NTIS HC A12/MF A02 CSCL 14B

From the time that wind tunnel wall interference was recognized to be significant, researchers have been developing methods to alleviate or account for it. Despite the best effort so far, it appears that no method is available which completely eliminates the effects due to the wind tunnel walls. This report discusses procedures developed for slotted wall and adaptive wall test sections of the Langley 0.3-m Transonic Cryogenic Tunnel (TCT) to assess and correct for the residual interference by methods consistent with the transonic nature of the tests. Author

N90-17649*# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Goettingen (Germany, F.R.). Inst. fuer Experimentelle Stroemungsmechanik.
COMPARISON OF CONVENTIONAL AND ADAPTIVE WALL WIND TUNNEL RESULTS WITH REGARD TO REYNOLDS NUMBER EFFECTS
E. Stanewsky and P. Freimuth *In* NASA, Langley Research Center, CAST-10-2/DOA 2 Airfoil Studies Workshop Results Nov. 1989 p 37-46 (For primary document see N90-17647 10-09)
Avail: NTIS HC A12/MF A02 CSCL 14B

A comparison of results from conventional and adaptive wall wind tunnels with regard to Reynolds number effects was carried out. The special objective of this comparison was to confirm or reject earlier conclusions, soley based on conventional wind tunnel

results, concerning the influence of viscous effects on the characteristics of partially open wind tunnel walls, hence wall interference. The following postulations could be confirmed: (1) certain classes of supercritical airfoils exhibit a non-linear increase in lift which is, at least in part, related to viscous-inviscid interactions on the airfoil. This non-linear lift characteristic can erroneously be suppressed by sidewall interference effects in addition to being affected by changes in Reynolds number. Adaptive walls seem to relieve the influence of sidewall interference; (2) the degree of (horizontal) wall interference effects can be significantly affected by changes in Reynolds number, thus appearing as true Reynolds number effects; (3) perforated wall characteristics seem much more susceptible to viscous changes than the characteristics of slotted walls; here, blockage interference may be most severely influenced by viscous changes; and (4) real Reynolds number effects are present on the CAST 10-2/DOA 2 airfoil; they were shown to be appreciable also by the adaptive wall wind tunnel tests. K.C.D.

N90-17650*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

HIGH REYNOLDS NUMBER TESTS OF THE CAST-10-2/DOA 2 TRANSONIC AIRFOIL AT AMBIENT AND CRYOGENIC TEMPERATURE CONDITIONS **c02**

E. Stanewsky, F. Demurie (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Goettingen, Germany, F.R.), Edward J. Ray, and C. B. Johnson *In its* CAST-10-2/DOA 2 Airfoil Studies Workshop Results Nov. 1989 p 47-60 (For primary document see N90-17647 10-09)

Avail: NTIS HC A12/MF A02 CSCL 01A

The transonic airfoil CAST 10-2/DOA 2 was investigated in several major transonic wind tunnels at Reynolds numbers ranging from Re=1.3 x 10(exp 6) to 45 x 10(exp 6) at ambient and cryogenic temperature conditions. The main objective was to study the degree and extent of the effects of Reynolds number on both the airfoil aerodynamic characteristics and the interference effects of various model-wind-tunnel systems. The initial analysis of the CAST 10-2 airfoil results revealed appreciable real Reynolds number effects on this airfoil and showed that wall interference can be significantly affected by changes in Reynolds number thus appearing as true Reynolds number effects. Author

N90-17651*# Institut fuer Theoretische Stroemungsmechanik, Goettingen (Germany, F.R.).

SOME NAVIER-STOKES CALCULATIONS FOR THE CAST-10 AIRFOIL **c02**

D. Schwamborn *In* NASA, Langley Research Center, CAST-10-2/DOA 2 Airfoil Studies Workshop Results Nov. 1989 p 61-81 (For primary document see N90-17647 10-09)

Avail: NTIS HC A12/MF A02 CSCL 01A

Results of the simulation of the viscous flow past the CAST-10 airfoil were shown for different flow conditions. Since the experiments provide only surface pressures and force coefficients, the comparison to the numerical results relies on these. Good agreement of these results is found for the lower Mach number cases except for the shock position. As numerical experiments indicate, this seems to be due to the turbulent shock boundary layer interaction which is not correctly modelled by the algebraic turbulence model employed. For the lower Mach number case the influence of the transition location was investigated, too. Changing the transition location at the lower surface has much more influence on the pressure distribution than changing it on the upper side. For the higher Mach number case the double shock structure found in the experiment for the lower Reynolds numbers was not reproduced by the numerical solutions. The reason for this is unknown though it may be due to the turbulence modelling. For the higher Reynolds number a better resolution of the boundary layer is needed in the computation in order to recover the experimental pressure plateau; but then the shock position is still found downstream of the experimental one. K.C.D.

N90-17652*# Centre d'Etudes et de Recherches, Toulouse (France).

MAIN RESULTS OF CAST-10 AIRFOIL TESTED IN T2 CRYOGENIC WIND TUNNEL **c02**

A. Blanchard, A. Seraudie, and J. F. Breil *In* NASA, Langley Research Center, CAST-10-2/DOA 2 Airfoil Studies Workshop Results Nov. 1989 p 83-98 (For primary document see N90-17647 10-09)

Avail: NTIS HC A12/MF A02 CSCL 01A

The aim of this cooperative NASA/DFVLR/ONERA project was to examine the performance of the CAST-10 airfoil in the T2 cryogenic wind tunnel. Tests included general characteristics of the CAST-10 airfoil and fundamental studies on Reynold number effects. Good T2 cryogenic operation was observed. Improvements should be done for moisture elimination and for side wall boundary layer effects. K.C.D.

N90-17653*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

AN EXPERIMENTAL AWTS PROCESS AND COMPARISONS OF ONERA T2 AND 0.3-m TCT AWTS DATA FOR THE ONERA CAST-10 AEROFOIL **c02**

Stephen Wolf (Vigyan Research Associates, Inc., Hampton, VA.) and Renaldo Jenkins *In its* CAST-10-2/DOA 2 Airfoil Studies Workshop Results Nov. 1989 p 137-153 (For primary document see N90-17647 10-09)

Avail: NTIS HC A12/MF A02 CSCL 01A

An experimental Adaptive Wall Test Section (AWTS) process is described. Comparisons of the ONERA T2 and the 0.3-m TCT (transonic cryogenic tunnel) AWTS data for the ONERA CAST-10 airfoil are presented. Most of the 0.3-m TCT data is new and preliminary and no sidewall boundary layer control is involved. No conclusions are given. K.C.D.

N90-17654*# National Aeronautical Establishment, Ottawa (Ontario).

INVESTIGATION OF CAST-10-2/DOA 2 AIRFOIL IN NAE HIGH REYNOLDS NUMBER TWO-DIMENSIONAL TEST FACILITY **c02**

Y. Y. Chan *In* NASA, Langley Research Center, CAST-10-2/DOA 2 Airfoil Studies Workshop Results Nov. 1989 p 155-174 (For primary document see N90-17647 10-09)

Avail: NTIS HC A12/MF A02 CSCL 01A

A common airfoil model with the CAST 10-2/DOA-2 profile and 228 mm (9 inches) chord length was tested. The tests performed in NAE covered the Mach numbers from 0.3 to 0.8 and Reynolds numbers from 10 to 30 million. The model was tested with transition free and with transition fixed at 5 percent chord for both the upper and the lower surfaces. The data obtained were analyzed for the effects of Reynolds number, transition fixing and Mach number. The role of the boundary layer on the displacement effect, the interaction with the shock wave and the trailing edge separation are examined. The results are summarized as follows: (1) the airfoil performance depends strongly on Reynolds number and transition fixing; (2) with transition fixed, the aerodynamic quantities such as lift, pitching moment and drag show a monotonic variation with Reynolds number; (3) with transition free, the aerodynamic quantities vary less regularly with Reynolds number and a slight parametric dependency is shown. The weak dependency is due to the compensatory effect of the forward shift of the transition position and the thinning of the turbulent boundary layer as Reynolds number increases; (4) the shock Mach number and the shock position are weakly dependent on Reynolds number; and (5) the long extent of the laminar boundary layer at transonic speeds reduces the drag appreciably at low Reynolds numbers. The drag bucket around the design Mach number can be observed below Reynolds number 15 million. K.C.D.

N90-17655*# National Aeronautical Establishment, Ottawa (Ontario).

RESIDUAL INTERFERENCE AND WIND TUNNEL WALL ADAPTION

Miroslav Mokry *In* NASA, Langley Research Center, CAST-10-2/DOA 2 Airfoil Studies Workshop Results Nov. 1989 p 175-193 (For primary document see N90-17647 10-09)
Avail: NTIS HC A12/MF A02 CSCL 14B

Measured flow variables near the test section boundaries, used to guide adjustments of the walls in adaptive wind tunnels, can also be used to quantify the residual interference. Because of a finite number of wall control devices (jacks, plenum compartments), the finite test section length, and the approximation character of adaptation algorithms, the unconfined flow conditions are not expected to be precisely attained even in the fully adapted stage. The procedures for the evaluation of residual wall interference are essentially the same as those used for assessing the correction in conventional, non-adaptive wind tunnels. Depending upon the number of flow variables utilized, one can speak of one- or two-variable methods; in two dimensions also of Schwarz- or Cauchy-type methods. The one-variable methods use the measured static pressure and normal velocity at the test section boundary, but do not require any model representation. This is clearly of an advantage for adaptive wall test section, which are often relatively small with respect to the test model, and for the variety of complex flows commonly encountered in wind tunnel testing. For test sections with flexible walls the normal component of velocity is given by the shape of the wall, adjusted for the displacement effect of its boundary layer. For ventilated test section walls it has to be measured by the Calspan pipes, laser Doppler velocimetry, or other appropriate techniques. The interface discontinuity method, also described, is a genuine residual interference assessment technique. It is specific to adaptive wall wind tunnels, where the computation results for the fictitious flow in the exterior of the test section are provided. Author

N90-17656*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
COMPARISON OF NAE POROUS WALL AND NASA ADAPTIVE WALL TEST RESULTS USING THE NAE CAST-10 AIRFOIL MODEL
Raymond E. Mineck *In its* CAST-10-2/DOA 2 Airfoil Studies Workshop Results Nov. 1989 p 195-212 (For primary document see N90-17647 10-09)
Avail: NTIS HC A12/MF A02 CSCL 14B

Wind tunnels can now simulate flows over airfoils at high Reynolds numbers and high subsonic speeds. Methods to correct for (or reduce) test section wall interference at these test conditions must be validated. The National Aeronautics Establishment (NAE) of Canada and NASA have a cooperative agreement to study this area. The NAE designed, built, and tested a CAST-10 airfoil model in its conventional Two-Dimensional High Reynolds Number Facility. The results were corrected using classical correction techniques. NASA then tested the same model in its 0.3-meter Transonic Cryogenic Tunnel with the adaptive wall test section. The adaptive wall test section reduced the wall interference to what was expected to be an acceptable level. The corrected NAE results are compared with the uncorrected NASA results. The NAE results are also compared with NASA results after residual corrections for top and bottom wall interference. Finally, a comparison of both sets of results corrected for interference from all four walls is presented. Author

N90-17657*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
EXPERIENCE WITH SOME REPEAT TESTS ON THE 9 INCH CHORD CAST-10-2/DOA 2 AIRFOIL MODEL IN THE LANGLEY 0.3-m TCT ADAPTIVE WALL TEST SECTION c02
A. V. Murthy (Vigyan Research Associates, Inc., Hampton, VA.) and Edward J. Ray *In its* CAST-10-2/DOA 2 Airfoil Studies Workshop Results Nov. 1989 p 213-231 (For primary document see N90-17647 10-09)
Avail: NTIS HC A12/MF A02 CSCL 01A

A co-operative testing program is in progress between the Langley Research Center (NASA) and the National Aeronautical Establishment (NAE, Canada) to validate two different techniques of airfoil testing at transonic speeds. The procedure employed is to test the same airfoil model in the NAE two-dimensional tunnel and the Langley 0.3-m Transonic Cryogenic Tunnel (0.3-m TCT). The airfoil model used in testing was CAST-10-2/DOA-2 super-critical airfoil. The Langley 0.3-m TCT has a relatively small cross section of 13 in x 13 in, giving a (h/c) ratio of 1.44 for the same 9 in chord model. The approach employed in the 0.3-m TCT aims towards eliminating the wall effects by using active walls. The top and bottom walls are flexible. By changing the wall shapes during a test in an iterative manner, the wall interference effects are reduced. The method employed to change the wall shapes is the adaptive wall technique. The current test program provided an opportunity to validate the adaptive wall technique in the 0.3-m TCT. The relatively long chord airfoil represents a severe test case to test the efficacy of the adaptive wall technique under cryogenic conditions. The program also involved removal of side wall boundary-layer thus increasing the complexity of the wall adaptation technique. This paper deals with some salient results obtained regarding repeatability of test data and possible residual interference effects. Author

N90-17658*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
COMPARISON OF TWO- AND THREE-DIMENSIONAL NAVIER-STOKES SOLUTIONS WITH NASA EXPERIMENTAL DATA FOR CAST-10 AIRFOIL c02
R. Charles Swanson, Rolf Radespiel, and V. Edward McCormick (North Carolina State Univ., Raleigh.) *In its* CAST-10-2/DOA 2 Airfoil Studies Workshop Results Nov. 1989 p 233-258 (For primary document see N90-17647 10-09)
Avail: NTIS HC A12/MF A02 CSCL 01A

The two-dimensional (2-D) and three-dimensional Navier-Stokes equations are solved for flow over a NAE CAST-10 airfoil model. Recently developed finite-volume codes that apply a multistage time stepping scheme in conjunction with steady state acceleration techniques are used to solve the equations. Two-dimensional results are shown for flow conditions uncorrected and corrected for wind tunnel wall interference effects. Predicted surface pressures from 3-D simulations are compared with those from 2-D calculations. The focus of the 3-D computations is the influence of the sidewall boundary layers. Topological features of the 3-D flow fields are indicated. Lift and drag results are compared with experimental measurements. Author

N90-17659# Naval Medical Research Inst., Bethesda, MD.
METHODOLOGY USED FOR GAS ANALYSIS AND CONTROL OF TRACE CHEMICAL CONTAMINANTS AT A HYPERBARIC FACILITY. 1: GAS SAMPLING Final Report, 1984 - 1988
R. S. Lillo, P. K. Weathersby, J. M. Caldwell (Naval Submarine Medical Research Lab., Groton, CT.), B. Franklin, and E. T. Flynn Dec. 1988 51 p Sponsored by Naval Medical Research and Development Command, Bethesda, MD
(AD-A216155; NMRI-88-92) Avail: NTIS HC A04/MF A01 CSCL 23/5

The Naval Medical Research Institute (NMRI) currently conducts human hyperbaric research in a large pressure chamber complex originally installed in 1977. An early incident of organic chemical contamination demonstrated the need for a set of procedures for contaminant analysis, control, and removal that were appropriate for hyperbaric operations. Because such a comprehensive set of guidelines were nonexistent, the development of such methodology was undertaken. This has resulted in the establishment of a gas analysis laboratory in support of diving operations that insures the safety of the chamber atmosphere and gas supply for human diving experiments. This report describes one aspect of this program, that of gas sampling, at the Diving Medicine Department at NMRI. Sampling in this context refers to the collection of gas for subsequent chemical analysis. Because of the large potential for sampling error when working with trace hydrocarbon mixtures, correct gas sampling techniques are extremely important. GRA

N90-17807# Universidad Politecnica de Madrid (Spain). Instituto de Energia Solar.
IMPROVED SOLAR CELLS TESTING FIXTURES

G. Sala, J. Aguilera, J. C. Zamorano, E. Sanchez, A. M. Grass, and T. J. Gomez (Instituto Nacional de Tecnica Aeroespacial, Esteban Terradas, Torrejon de Ardoz, Spain) *In* ESA, European Space Power, Volume 2 Aug. 1989 p 843-849 (For primary document see N90-17748 10-20)
Copyright Avail: NTIS HC A16/MF A03

12 ASTRONAUTICS (GENERAL)

For extraterrestrial exploration see *91 Lunar and Planetary Exploration.*

No abstracts in this category.

13 ASTRODYNAMICS

Includes powered and free-flight trajectories; and orbital and launching dynamics.

N90-17660# Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil). Ministerio da Ciencia e Tecnologia.
SIMULATION OF SHADING IN SYNTHETIC SURFACES
Moacir GodyJunior and Guaraci Jose Erthal Aug. 1989 7 p In PORTUGUESE; ENGLISH summary Presented at the 5th Brazilian Symposium on Remote Sensing, Natal, Brazil, 11-15 Oct. 1988
(INPE-4869-PRE/1480) Avail: NTIS HC A02/MF A01

To adequately specify a satellite orbit it is necessary to access the illumination level on the ground at different times. Generic information about the irradiance on the surface can be easily found in tables. However the orbit passing time does not only affect the irradiance on the horizontal plane, but also the shadowing level, which varies with topography, sun elevation, and azimuth. In this way, to define the best satellite crossing time it is important to have a system for evaluating the number of pixels which would be in the shadow under different illumination and topographic conditions. The simulation of shadowing patterns is performed by using synthetic surfaces for different topographic classes. The effect of illumination variation is also assessed and the number of shadowing pixels are computed. The developed model can also be applied to real surfaces. Author

N90-17661# Naval Postgraduate School, Monterey, CA. Dept. of Aeronautics and Astronautics.
SATELLITE MOTION AROUND AN OBLATE PLANET: A PERTURBATION SOLUTION FOR ALL ORBITAL PARAMETERS Ph.D. Thesis
James Ralph Snider Jun. 1989 128 p
(AD-A216176) Avail: NTIS HC A07/MF A01 CSCL 22/3

The search for a universal solution of the equations of motion for satellite orbiting an oblate planet is a subject that has merited great interest because of its theoretical implications and practical applications. The discovery of such a solution should motivate a reassessment of both the theories that exhibit singularities and the physical effects implied by singularities. The practical importance of such a solution is the efficiency of simple analytic formulas in predicting simultaneously the paths of large numbers of satellites in a multitude of orbits. Here, a complete first order solution to the problem of a satellite, perturbed only by the oblateness of the Earth, is displayed. The orbit is free of singularities for all parameters and is valid for 1000 revolutions with a relative error of the order J-sq approx. = .000001. GRA

N90-17662# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
INVESTIGATION OF THE OBSERVABILITY OF A SATELLITE CLUSTER IN A NEAR CIRCULAR ORBIT M.S. Thesis
Sherrie Norton Filer Dec. 1989 72 p
(AD-A216224; AFIT/GA/ENY/89D-2) Avail: NTIS HC A04/MF A01 CSCL 22/3

The relative position determination of a cluster of satellites in a near circular orbit was previously investigated with the use of dynamics based on the Clohessy-Wiltshire equations and an on-board estimator based on the U-D covariance factorization version of the Kalman filter. The initial performance results proved favorable, with the filter meeting the required 25 meter accuracy in all test cases. The test results achieved by Captain Ward are validated and the ability of the filter to determine the relative position of the satellites to a higher degree when the filter in use is not resident on that satellite is investigated. This investigation included the use of additional measurement data from other satellites in the cluster to the Kalman filter for processing in the update cycle. When it was determined that the measurements were not allowing satellite 1 to update, the observability of the components of the state vector were computed and the results discussed. GRA

14 GROUND SUPPORT SYSTEMS AND FACILITIES (SPACE)

Includes launch complexes, research and production facilities; ground support equipment, e.g., mobile transporters; and simulators.

For related information see also *09 Research and Support Facilities (Air).*

N90-17663# Japan Atomic Energy Research Inst., Tokyo. Dept. of Thermonuclear Fusion Research.
DESIGN OF JT-60U ICRF LAUNCHER
Mikio Saigusa, Haruyuki Kimura, Tsuneyuki Fujii, Noriyuki Kobayashi, Shin-ichi Moriyama, Katsuto Annoh, Yoshiro Ogawa, Shin-ichi Shinozaki, and Masayuki Terakado Aug. 1989 37 p In JAPANESE; ENGLISH summary
(DE90-733145; JAERI-M-89-105) Avail: NTIS (US Sales Only) HC A03/MF A01

JT-60U ICRF launcher is designed based on the measurement of electromagnetic field profile in front of a test launcher and the calculation of coupling properties. The coupling code was made for the antenna array whose each antenna element was recessed in a metal box and was a trombone shape. The image current induced on the metal separator degrates the loading resistance for only in-phase. The loading resistance of designed antenna is predicted to be over 2 Omega for out of phase in a H-mode like density profile with the distance of 6 cm between the sparatrix surface and the launcher. DOE

N90-17664# Lawrence Livermore National Lab., CA.
HYPERVELOCITY ACCELERATION AND IMPACT EXPERIMENTS WITH THE LLNL ELECTRIC GUN
J. Osher, R. Gathers, H. Chau, R. Lee, G. Pomykal, and R. Weingart 11 Dec. 1989 15 p Presented at the Hypervelocity Impact Symposium, San Antonio, TX, 12-14 Dec. 1989
(Contract W-7405-eng-48)
(DE90-006924; UCRL-100629; CONF-891214-16) Avail: NTIS HC A03/MF A01

In the electric gun, the explosion of an electrically heated metal foil and the accompanying magnetic forces are used to accelerate a thin flyer plate to velocities as high as 18 km/s. Here we report preliminary results of a study to extend this capability to the acceleration of projectiles or particles ranging in size from micrometeorites to chunky projectiles with a mass as high as 0.5 g. We also have started code calculations of projectile impacts on thick aluminum witness plates for comparison with observations of experimentally produced cratering. DOE

15 LAUNCH VEHICLES AND SPACE VEHICLES

Includes boosters; operating problems of launch/space vehicle systems; and reusable vehicles.

For related information see also *20 Spacecraft Propulsion and Power.*

No abstracts in this category.

16 SPACE TRANSPORTATION

Includes passenger and cargo space transportation, e.g., shuttle operations; and space rescue techniques.

For related information see also *03 Air Transportation and Safety* and *18 Spacecraft Design, Testing and Performance.* For space suits see *54 Man/System Technology and Life Support.*

No abstracts in this category.

17 SPACE COMM., SPACECRAFT COMM., COMMAND & TRACKING

Includes telemetry; space communications networks; astronavigation and guidance; and radio blackout.

For related information see also *04 Aircraft Communications and Navigation* and *32 Communications and Radar.*

N90-17665# Range Commanders Council, White Sands Missile Range, NM. Telemetry Group.

THE 15TH TRANSDUCER WORKSHOP Final Report

Jun. 1989 277 p Workshop held in Cocoa Beach, FL, 20-22 Jun. 1989

(AD-A215515) Avail: NTIS HC A13/MF A01 CSCL 14/4

The committee apprizes the telemetry group (TG) of significant progress in the field of transducers used in telemetry systems. It also maintains any necessary liaison between the TG and the National Bureau of Standards and their transducers program or other related telemetry transducer efforts. It also coordinates TG activities with other professional technical groups, and collects and passes on information on techniques of measurement, evaluation, reliability, calibration, reporting, and manufacturing. The committee also recommends uniform practices for calibration, testing, and evaluation of vehicular instrumentation components, and contributes to standards in the area of vehicular instrumentation. GRA

N90-17666# Naval Postgraduate School, Monterey, CA.

NEAR REAL TIME VHF TELEMETRY OF NEAR SHORE OCEANOGRAPHIC DATA M.S. Thesis

Douglas L. McKinney Jun. 1989 103 p

(AD-A215756) Avail: NTIS HC A06/MF A01 CSCL 09/6

This thesis reports on the development and tests of a low cost automated telemetry system. This system daily transmits the last 24 hours of collected data from a near shore moored buoy system. Investigation into the different telemetry modes resulted in selecting a very high frequency (VHF) narrow band frequency modulation (NBFM) packet networking system. The telemetry system features line-of-sight propagation, resistance to radio interference and includes a digital error checking routine. The equipment used in VHF NBFM packet is light weight, has low power consumption and is inexpensive when used with commercially available amateur radio equipment. Tests of a prototype system suggest that a VHF NBFM packet system is a practical tool for near shore buoy telemetry of in situ oceanographic data. GRA

18 SPACECRAFT DESIGN, TESTING AND PERFORMANCE

Includes satellites; space platforms; space stations; spacecraft systems and components such as thermal and environmental controls; and attitude controls.

For life support systems see *54 Man/System Technology and Life Support.* For related information see also *05 Aircraft Design, Testing and Performance, 39 Structural Mechanics,* and *16 Space Transportation.*

N90-17667*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

PRELIMINARY INVESTIGATION OF PARAMETER SENSITIVITIES FOR ATMOSPHERIC ENTRY AND AEROBRAKING AT MARS

Mary C. Lee and William T. Suit Sep. 1989 30 p

(NASA-TM-101607; NAS 1.15:101607) Avail: NTIS HC A03/MF A01 CSCL 22B

The proposed manned Mars mission will need to be as weight efficient as possible. A way of lowering the weight of the vehicle by using aeroassist braking instead of retro-rockets to slow a craft once it reaches its destination is discussed. The two vehicles studied are a small vehicle similar in size to the Mars Rover Sample Return (MRSR) vehicle and a larger vehicle similar in size to a six-person Manned Mars Mission (MMM) vehicle. Simulated entries were made using various coefficients of lift (C sub L), coefficients of drag (C sub D), and lift-to-drag ratios (L/D). A range of acceptable flight path angles with their corresponding bank angle profiles was found for each case studied. These ranges were then compared, and the results are reported here. The sensitivity of velocity and acceleration to changes in flight path angle and bank angle is also included to indicate potential problem areas for guidance and navigation system design. Author

N90-17668# Naval Research Lab., Washington, DC.

CHEMICAL INTERACTIONS AND LIGHT EMISSIONS FROM VENTED SPECIES Final Report, Jun. 1988 - Mar. 1989

P. A. Bernhardt and M. J. Mulbrandon 20 Oct. 1989 45 p

(AD-A214130; NRL-MR-6527) Avail: NTIS HC A03/MF A01 CSCL 04/1

Airglow emissions may be induced by the interaction of atmospheric constituents with vapors released from space vehicles. Such emissions can be produced by a number of chemical mechanisms. This study considers neutral-plasma reactions as well as neutral-neutral reactions as the sources for excited species. The intensities of light emissions produced by the release of water and methyl alcohol into the upper atmosphere is estimated with a numerical mode. Chemical reactions between the injected neutrals, background ions, electrons, and neutrals, and artificially created ions and neutrals are considered. We find that OH is the primary excited species resulting from the water release. Vibrational and electronic states of OH will be excited to yield emission spectra between 240 and 4400 nm wavelengths. For the release of 10 to the 26th power molecules in the nighttime ionosphere with a density of 10 to the 6th power/cu cm, the intensities of the emissions will be greater than .0001 Rayleighs. The water release also produces vibrational states of H2O and electronic states of atomic oxygen. The addition of methyl alcohol to the release causes substantial production of vibrationally excited formaldehyde. It is concluded that the venting of reactive molecules into the upper atmosphere at 300 km altitude or above can produce excited species by neutral-neutral, ion-neutral, or electron-ion reactions. No one reaction process is dominant in the F-region. GRA

N90-17669# Consiglio Nazionale delle Ricerche, Frascati (Italy). Ist. di Fisica dello Spazio Interplanetario.
ACCELERATION TESTS OF THE ACPB CANISTER FLIGHT UNIT FROM RETE EXPERIMENT [PROVE DI ACCELERAZIONE DELL'UNITA' DA VOLO ACBP CANISTER DELL'ESPERIMENTO RETE]
Paolo Baldetti Jan. 1989 33 p Partly in FRENCH and ITALIAN
(IFSI-89-2; ETN-90-96164) Avail: NTIS HC A03/MF A01

Accleration tests of a satellite system component were carried out using a large centrifugal accelerator. Details of the measurements made on three axes and up to 22.5 g are presented. ESA

N90-17670# Consiglio Nazionale delle Ricerche, Frascati (Italy). Ist. di Fisica dello Spazio Interplanetario.
VIBRATION TESTS OF THE ACPB CANISTER FLIGHT UNIT OF THE RETE EXPERIMENT, INTEGRATED WITH THE TESTS OF THE BOOMS FROM R. PIAGGIO [PROVE DI VIBRAZIONE DELL'UNITA DA VOLO ACBP CANISTER DELL'ESPERIMENTO RETE INTEGRATO CON I BOOM DELLA R. PIAGGIO SPA]
Paolo Baldetti May 1989 61 p Partly in ENGLISH and ITALIAN Original contains color illustrations
(IFSI-89-11; ETN-90-96173) Avail: NTIS HC A04/MF A01

The vibration tests are made using work planes vibrating in two different axis. The booms are fixed to the same table. The test specification for the boom mechanical unit of the deployable retrievable boom are detailed and include functional and performance tests, resonance search tests and random vibrations tests. Resonant frequencies of the coupled boom and ACPB are about 30 Hz. ESA

N90-17671# Lawrence Livermore National Lab., CA. Dept. of Electronics Engineering.
GENERATING OPTIMALLY EVASIVE MaRV TRAJECTORIES
Donald T. Gavel Oct. 1988 58 p
(Contract W-7405-eng-48)
(DE90-004496; UCID-21570) Avail: NTIS HC A04/MF A01

The advent of maneuvering reentry vehicles (MaRV's) has spurred the need to develop evasive maneuver strategies which: (1) are within the aerodynamic performance limits of the MaRV, (2) end up at the intended target, and (3) optimize trajectory characteristics which may increase the probability of penetration through an ABM defense. An algorithmic approach to automatically generating trajectories which meet these criteria is presented. DOE

N90-17672# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
CONTROL AND STABILITY OF A SPINNING SYMMETRIC SATELLITE IN AN ELLIPTICAL ORBIT M.S. Thesis
James Walter Cole Dec. 1989 129 p
(AD-A216284; AFIT/GAE/ENY/89D-05) Avail: NTIS HC A07/MF A01 CSCL 22/3

This work is a continuation of work done by Shell in the stability evaluation of a scalar control applied to a time periodic system. The scalar controlled satellite is examined in a new controlled modal coordinate system. This coordinate system decouples the four modes of the linearized system with the controller. The stability of each mode can easily be evaluated in the uncoupled form. The stability of a spinning symmetric satellite in an elliptical orbit is analyzed using phase planes and surface of section techniques. The equations of motion for the satellite attitude are presented in a linearized and a non-linear form. Floquet Theory is applied to the development of a control system for two unstable modes of the satellite. A scalar control is applied using angle rates as feedback. The stability of the new controlled system is examined in controlled modal coordinates. Comparisons of the linear and non-linear system motions are made relative to changes in the control gains. Potential chaotic motion limits the controller gains of the non-linear system. GRA

N90-17673# Aerospace Corp., El Segundo, CA. Electronics Research Lab.
A SPACE-FED LOCAL OSCILLATOR FOR SPACEBORNE PHASED ARRAYS
Gwendolyn M. Shaw and Robert B. Dybdal 21 Dec. 1989 27 p
(Contract F04701-85-C-0086)
(AD-A216526; TR-0088(3925-05)-1; SSD-TR-89-89) Avail: NTIS HC A03/MF A01 CSCL 22/2

Deployable, spaceborne phase-array antennas require lightweight structures that are nonrigid and deform dynamically in orbit. These array deformations are described by a time- and amplitude-weighted sum of characteristic mechanical modes of the array structure. These mechanical deformations degrade the array's radiation performance by reducing the gain, increasing the sidelobes, and generating pointing errors. The effects of these mechanical deformations can be partially compensated for by a space-fed local oscillator. This space-fed local oscillator uses a radiator on the back of the array to transmit the local oscillator signal to pickup elements connected to the array elements. This technique also potentially lowers the array's weight, eases its mechanical deployment, and reduces the complexity of its design. GRA

N90-17674*# Boeing Aerospace Co., Seattle, WA.
SPACE STATION CONTAMINATION CONTROL STUDY: INTERNAL COMBUSTION, PHASE 1 Final Report, Jun. 1985 - Sep. 1986
Robert T. Ruggeri 9 Feb. 1987 299 p
(Contract NAS8-36432)
(NASA-CR-179323; NAS 1.26:179323) Avail: NTIS HC A13/MF A02 CSCL 22B

Contamination inside Space Station modules was studied to determine the best methods of controlling contamination. The work was conducted in five tasks that identified existing contamination control requirements, analyzed contamination levels, developed outgassing specification for materials, wrote a contamination control plan, and evaluated current materials of offgassing tests used by NASA. It is concluded that current contamination control methods can be made to function on the Space Station for up to 1000 days, but that current methods are deficient for periods longer than about 1000 days. Author

N90-17675*# Honeywell, Inc., Glendale, AZ. Satellite Systems Div.
ASTROMETRIC TELESCOPE FACILITY ISOLATION AND POINTING STUDY Final Report
William Hibble, Terry Allen, Louis Jackson, James Medbery, and Richard Self Jan. 1988 102 p
(Contract NAS2-32815)
(NASA-CR-177473; NAS 1.26:177473) Avail: NTIS HC A06/MF A01 CSCL 22B

The Astrometric Telescope Facility (ATF), an optical telescope designed to detect extrasolar planetary systems, is scheduled to be a major user of the Space Station's Payload Pointing System (PPS). However, because the ATF has such a stringent pointing stability specification and requires + or - 180 deg roll about its line of sight, mechanisms to enhance the basic PPS capability are required. The ATF pointing performance achievable by the addition of a magnetic isolation and pointing system (MIPS) between the PPS upper gimbal and the ATF, and separately, by the addition of a passive isolation system between the Space Station and the PPS base was investigated. The candidate MIPS can meet the ATF requirements in the presence of a 0.01 g disturbance. It fits within the available annular region between the PPS and the ATF while meeting power and weight limitations and providing the required roll motion, payload data and power services. By contrast, the passive base isolator system must have an unrealistically low isolation bandwidth on all axes to meet ATF pointing requirements and does not provide roll about the line of sight. Author

N90-17806# Ingenieurbuero Krueger, Darmstadt (Germany, F.R.).
SIMULATION OF MICROMETEOROID IMPACTS BY LASER PULSES
F. R. Krueger, D. Maas, K. Rohr, M. Rott, and K. Bogus (European Space Agency. European Space Research and Technology Center, ESTEC, Noordwijk, Netherlands) *In* ESA, European Space Power, Volume 2 Aug. 1989 p 837-842 (For primary document see N90-17748 10-20)
Copyright Avail: NTIS HC A16/MF A03

19 SPACECRAFT INSTRUMENTATION

For related information see also *06 Aircraft Instrumentation* and *35 Instrumentation and Photography.*

No abstracts in this category.

20 SPACECRAFT PROPULSION AND POWER

Includes main propulsion systems and components, e.g., rocket engines; and spacecraft auxilliary power sources.

For related information see also *07 Aircraft Propulsion and Power, 28 Propellants and Fuels, 44 Energy Production and Conversion,* and *15 Launch Vehicles and Space Vehicles.*

N90-17676*# Old Dominion Univ., Norfolk, VA.
PLUME FLOWFIELD ANALYSIS OF THE SHUTTLE PRIMARY REACTION CONTROL SYSTEM (RCS) ROCKET ENGINE Final Report
J. E. Hueser and F. J. Brock Jan. 1990 123 p
(Contract NCC1-94)
(NASA-CR-186315; NAS 1.26:186315) Avail: NTIS HC A06/MF A01 CSCL 21H

A solution was generated for the physical properties of the Shuttle RCS 4000 N (900 lb) rocket engine exhaust plume flowfield. The modeled exhaust gas consists of the five most abundant molecular species, H2, N2, H2O, CO, and CO2. The solution is for a bare RCS engine firing into a vacuum; the only additional hardware surface in the flowfield is a cylinder (=engine mount) which coincides with the nozzle lip outer corner at X = 0, extends to the flowfield outer boundary at X = -137 m and is coaxial with the negative symmetry axis. Continuum gas dynamic methods and the Direct Simulation Monte Carlo (DSMC) method were combined in an iterative procedure to produce a selfconsistent solution. Continuum methods were used in the RCS nozzle and in the plume as far as the P = 0.03 breakdown contour; the DSMC method was used downstream of this continuum flow boundary. The DSMC flowfield extends beyond 100 m from the nozzle exit and thus the solution includes the farfield flow properties, but substantial information is developed on lip flow dynamics and thus results are also presented for the flow properties in the vicinity of the nozzle lip. Author

N90-17677*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
PRELIMINARY EVALUATION OF SPACE STATION TRANSMISSION LINE IN A RING CONFIGURATION
Mary Ellen Roth Jan. 1990 7 p
(NASA-TM-102461; E-5248; NAS 1.15:102461) Avail: NTIS HC A02/MF A01 CSCL 10B

The results of a preliminary evaluation of a space station type transmission line and commercial transmission lines in a ring configuration, are reported. In a ring configuration, each node has two paths for the return current of each wire. The additional path can create an unbalanced condition, where the magnetic fields created by the forward and return currents do not cancel. This evaluation was to quantify the effects of the unbalanced case upon the external fields. The transmission lines evaluated were standard commercial coaxial cables, RG59 and RG213, and a space station designed flat Litz transmission line. Each was evaluated in a balanced and unbalanced mode of operation. Currents and their harmonic content were recorded and compared. As expected, the harmonic content of the different current (I delta) was substantial for the unbalanced case as compared to the balanced case. For the balanced case, very little difference was noted among the various transmission lines evaluated. The evaluation is discussed, and the test circuit, the measurements, and the resulting data are described. Author

N90-17678# European Space Agency, Paris (France).
EUROPEAN SPACE POWER, VOLUME 1
Jocelyne Landeau, ed. Aug. 1989 447 p Conference held in Madrid, Spain, 2-6 Oct. 1989; sponsored by ESA, Univ. Politecnica de Madrid, and Inst. Nacional de Tecnica Aeroespacial
(ESA-SP-294-Vol-1; ISSN-0379-6566; ETN-90-96194) Copyright Avail: NTIS HC A19/MF A03

Power systems for manned missions, power system equipment development modeling, and testing for a variety of space applications are discussed. Batteries and fuel cells, battery management, technology and testing techniques are described. Power electronics, modeling and analysis, and resonant and high voltage converters are discussed. The research and planning carried out by members of ESA in all of these areas is described. For individual titles, see N90-17679 through N90-17747.

N90-17679# Allgemeine Elektrizitaets-Gesellschaft, Wedel (Germany, F.R.).
THE 120 VDC TEST BED FOR COLUMBUS POWER SYSTEM
Michael Koss and Volker Leisten *In* ESA, European Space Power, Volume 1 Aug. 1989 p 5-12 (For primary document see N90-17678 10-20)
Copyright Avail: NTIS HC A19/MF A03

The results, objectives, and tasks of the test bed part of the Multiple Power Bus Management (MPBM) (bus voltage 120 voltage direct current, VDC) program are described. Hardware configurations, equipment modularity, growth potential, performance characteristics, and test results are discussed. An improved method of impedance measurement is presented. A short comparison between the MPBM results and the actual needs of the Columbus program is presented. ESA

N90-17680# National Space Development Agency, Tokyo (Japan).
JAPANESE EXPERIMENT MODULE ELECTRICAL POWER SYSTEM
Yasuki Kawamura *In* ESA, European Space Power, Volume 1 Aug. 1989 p 13-17 (For primary document see N90-17678 10-20)
Copyright Avail: NTIS HC A19/MF A03

The Japanese Experiment Module (JEM), an element of the Space Station, is described. The electrical power system is outlined. A 120 voltage direct current (VDC) power bus line is used. It will also be used on future Japanese Spacecraft. Power system management and control systems are described. The functions of JEM are verified by several different models including the power functional model, system architecture study, power confirming model and hardware models. Further study is proposed. ESA

N90-17681*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
TOWARD AN ELECTRICAL POWER UTILITY FOR SPACE EXPLORATION
Robert W. Bercaw *In* ESA, European Space Power, Volume 1 Aug. 1989 p 19-22 Previously announced as N89-27704 (For primary document see N90-17678 10-20)
Copyright Avail: NTIS HC A19/MF A03 CSCL 10B

Future electrical power requirements for space exploration are discussed. Megawatts of power with enough reliability for multi-year

missions and with enough flexibility to adapt to needs unanticipated at design time are some of the criteria which space power systems must be able to meet. The reasons for considering the power management and distribution in the various systems, from a total mission perspective rather than simply extrapolating current spacecraft design practice, are discussed. A utility approach to electric power integrating requirements from a broad selection of current development programs, with studies in which both space and terrestrial technologies are conceptually applied to exploration mission scenarios, is described. ESA

N90-17682# European Space Agency. European Space Research and Technology Center, ESTEC, Noordwijk (Netherlands).

THE HERMES POWER SYSTEM

B. Lacore, R. Prido, M. Tocque, and R. Hannon (Etudes Techniques et Constructions Aerospatiales, Charleroi, Belgium) *In its* European Space Power, Volume 1 Aug. 1989 p 23-29 (For primary document see N90-17678 10-20)

Copyright Avail: NTIS HC A19/MF A03

The design requirements of the Hermes manned spaceplane are described. Safety and reliability aspects are discussed. Mass reduction methods and interfaces with other vehicles are described. The Hermes system mission and functional requirements and their implications in power system design are presented. The various tradeoffs and their results are described. Performance of the system is predicted. ESA

N90-17683# Societe Crouzet, Valence (France).

THE 120V 10A SSPC FOR THE COLUMBUS PROGRAMME

F. Fachinetti and D. Levins (European Space Agency, Paris, France) *In* ESA, European Space Power, Volume 1 Aug. 1989 p 33-38 (For primary document see N90-17678 10-20)

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The Solid State Power Controller (SSPC) planned for incorporation into the power distribution network of Columbus is described. The SSPC switches the power line on and off, limits the output current in case of overload, and provides interfaces for easy use. The electrical design of the system is described. The design involves the use of thick film hybrid technology for the power sections and discrete parts for the rest of the electronics. A space qualified SSPC of less than 200 g mass is predicted. ESA

N90-17684# Dornier System G.m.b.H., Friedrichshafen (Germany, F.R.).

LIFE TEST PROGRAMME OF ERS-1 AMI-HIGH POWER AMPLIFIER

Kurt Rogalla *In* ESA, European Space Power, Volume 1 Aug. 1989 p 39-43 (For primary document see N90-17678 10-20)

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The high power amplifier (HPA) of the Active Microwave Instrument (AMI) onboard the ERS-1 satellite is described. It is basically composed of a traveling wave tube (TWT) and its electronic power conditioner (EPC). The system must be able to generate a peak power of 5.3 GHz over a minimum operational life of three years in orbit. New TWT and EPC technologies must be developed to achieve this goal. A comprehensive life test program developed to test the philosophy, approach, and results of the high voltage modules, the TWTs and HPAs is described. ESA

N90-17685# British Aerospace Public Ltd. Co., Bristol (England). Space Systems Div.

THE DESIGN AND PERFORMANCE OF A GENERAL PURPOSE 57 KILOWATT SOLAR ARRAY SIMULATOR FOR CURRENT AND FUTURE LARGE SPACECRAFT

K. M. Redford and A. B. Williams *In* ESA, European Space Power, Volume 1 Aug. 1989 p 45-51 (For primary document see N90-17678 10-20)

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The general purpose solar array power simulator is described. It provides a modular 57 kilowatt power source for ground testing of complete spacecraft or spacecraft power subsystems prior to launch. The equipment can provide power to shunt or series Array Switching Regulators (ASR), linear power subsystem regulators or battery charging regulators. Power is provided in array section modules of up to 1.5 kilowatts at 20 to 150 volts and 0 to 10 amps. The design, and performance characteristics of the completed simulator is described. ESA

N90-17686# Alcatel Espace, Toulouse (France).

THE COLUMBUS POWER SYSTEM SIMULATION PROGRAMME

J. vanDuivenbode and A. Capel *In* ESA, European Space Power, Volume 1 Aug. 1989 p 53-60 (For primary document see N90-17678 10-20)

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A simulation program used in integrating all the parameters involved in designing a space vehicle power system is described. The COLumbus MODel (COLMOD) program can evaluate a power system quickly by calculating the evolution of the battery charge, taking into account the influence of solar array characteristics, harness, power conditioning, and payload. The program calculates energy and mass balances. A menu interface designed to make the COLMOD program user friendly ensures direct feedback of simulation results to the user. ESA

N90-17687# Allgemeine Elektrizitaets-Gesellschaft, Wedel (Germany, F.R.).

NEW POWER SYSTEM MODELLING APPROACHES ON THE BASIS OF EQUIVALENT STATE VARIABLES

Gert Eggers *In* ESA, European Space Power, Volume 1 Aug. 1989 p 61-70 (For primary document see N90-17678 10-20)

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A method is presented which models switched-mode dc-to-dc power stages by using equivalent state variables. Compact analytical expressions in terms of bilinear forms are derived for the principal transfer functions. Conclusions concentrate on non-minimum phase properties of the considered power stages which seriously affect their stability behavior. Procedures regarding topology extension are developed in order to circumvent non-minimum phase properties. ESA

N90-17688# European Space Agency. European Space Research and Technology Center, ESTEC, Noordwijk (Netherlands).

THERMAL CHARACTERISTICS OF POWER MOS-FETS. RESULTS OBTAINED WITH THE IRF-250 **c33**

C. Delettrez and H. J. N. Spruyt *In its* European Space Power, Volume 1 Aug. 1989 p 71-77 (For primary document see N90-17678 10-20)

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Dynamic temperature testing on N-channel power metal oxide semiconductors-field effect transistors (MOS-FET) transistors (type IRF-250) is described. The test method was developed in order to optimize the inrush and overload capability of solid-state power distribution switches in order to be sure that the MOS-FET junction temperature is not exceeding a certain absolute temperature (115 C for space application). The idealized concept of thermal impedance and the different electrical methods for measuring the junction temperature are presented. A description of the test setup and the procedures are given, followed by examples of results obtained with different samples. Results are modeled and the conclusions summarized. ESA

N90-17689# Aerospatiale, Cannes (France). Space and Strategic Systems Div.

THE SPACEBUS POWER CONDITIONING APPLICATION TO THE EUTELSAT 2 SPACECRAFT

L. Broihanne and R. Asplanato *In* ESA, European Space Power, Volume 1 Aug. 1989 p 81-89 Sponsored by CNES (For primary document see N90-17678 10-20)

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A summary of the main features and performance of the Spacebus electrical power conditioning system is presented. The

subsystems consist of two nickel hydrogen batteries, and a rigid 3W solar array made up of honeycomb carbon fiber panels. The system was used on the Eutelsat 2 spacecraft since 1989. The unique characteristics of this system, especially as regards compatibility to its telecommunications payloads, are outlined.
ESA

N90-17690# British Aerospace Public Ltd. Co., Stevenage (England). Space Systems Div.
THE SUBSYSTEM REGULATOR, THE NEXT GENERATION IN SATELLITE REGULATED POWER CONDITIONING
Stephen King and Peter Alcindor *In* ESA, European Space Power, Volume 1 Aug. 1989 p 91-98 (For primary document see N90-17678 10-20)
Copyright Avail: NTIS HC A19/MF A03
The Subsystem Regulator (SSR), a single unit combining both sunlight and eclipse regulation with inherent battery charge capability, is described. This system incorporates the advantages of full regulation such as simple payload interfacing, single bus operation and elimination of latch up, without the mass and cost penalties normally associated with fully regulated systems. Results of the tradeoff study are presented. Improvements gained at the systems level are identified. ESA

N90-17691# European Space Agency. European Space Research and Technology Center, ESTEC, Noordwijk (Netherlands).
ANALYSIS OF POWER BUS TOPOLOGIES USED IN TELECOMMUNICATIONS SATELLITES
B. Lacore *In its* European Space Power, Volume 1 Aug. 1989 p 99-109 (For primary document see N90-17678 10-20)
Copyright Avail: NTIS HC A19/MF A03
Two concepts of power bus technology are presented: fully regulated bus and sunlight regulated bus. The impact of the bus voltage excursion on the various equipments constituting the power system is analyzed. Looking at system level, the choice of the number of batteries, the number of buses, the reliability and the hardware standardization are found to be highly dependent on the bus architecture. Mass, and efficiency consideration of the overall system is one of the prime criteria when choices are to be made. The impact of the bus configuration upon these parameters is presented. ESA

N90-17692# Fabrica Italiana Apparecchiature Radioelettriche S.p.A., Milan. Space Div.
AUTONOMOUS ELECTRICAL POWER SUPPLY SUBSYSTEM FOR THE VESTA MISSION
A. Orsi and A. Truffi *In* ESA, European Space Power, Volume 1 Aug. 1989 p 111-115 (For primary document see N90-17678 10-20)
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The architectural definition and design of the Autonomous Electrical Power Supply System (APS) for the Vesta small bodies spacecraft is described. Vesta is designed for a deep space scientific mission exploring asteroids and comets, and takes it's name from the Vesta asteroid. Implementation of the APS autonomy is achieved by means of both analog and digital electronic control. Tradeoff analysis for the selection of power conditioning is summarized and the microprocessor based APS Controller (APSC) is described. ESA

N90-17693*# National Aeronautics and Space Administration, Washington, DC.
ON THE DEVELOPMENT OF THE POWER SOURCES FOR THE ULYSSES AND GALILEO MISSIONS
Gary L. Bennett, C. W. Whitmore, and W. R. Amos (EG and G Mound Applied Technologies, Miamisburg, OH.) *In* ESA, European Space Power, Volume 1 Aug. 1989 p 117-121 (For primary document see N90-17678 10-20)
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The development of the Radioisotope Thermoelectric Generator (RTG) to be used on the Ulysses and Galileo missions is described. This RTG, designed to provide a minimum of 285 We at the beginning of the mission, builds upon the successful thermoelectric technology developed for the RTGs now in operation on the Voyager 1 and 2 spacecraft. A total of four flight RTGs, one ground qualification RTG, and one engineering unit have been built and tested for the Galileo and Ulysses missions. The tests have included measurements of functional performance, vibration response, magnetic signature, mass properties, nuclear radiation, and vacuum performance. The RTGs are fully flight qualified for both missions and are ready for launch. ESA

N90-17694# European Space Agency. European Space Research and Technology Center, ESTEC, Noordwijk (Netherlands).
A POWER SYSTEM FOR ARTEP
J. E. Haines, A. Weinberg, and S. Andersson *In its* European Space Power, Volume 1 Aug. 1989 p 123-129 (For primary document see N90-17678 10-20)
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The concept of a primary battery based power system for an Ariane-4 carried experiment platform is presented. The configuration described offers a standard 28 volt regulated dc experiment supply, electrically independent of Ariane interfaces. Together with modular growth potential, extremely low pre-activation power consumption and fail safe design techniques, the advantages of the system for powering the Ariane Technological Experiment Platform (ARTEP), are many. Circuit diagrams and breadboard test results of the power control unit are presented.
ESA

N90-17695*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
CHALLENGES FOR FUTURE SPACE POWER SYSTEMS
Henry W. Brandhorst, Jr. *In* ESA, European Space Power, Volume 1 Aug. 1989 p 133-136 Previously announced as N89-25506 (For primary document see N90-17678 10-20)
Copyright Avail: NTIS HC A19/MF A03 CSCL 10B
Forecasts of space power needs are presented. The needs fall into three broad categories: survival, self-sufficiency, and industrialization. The cost of delivering payloads to orbital locations and from Low Earth Orbit (LEO) to Mars are determined. Future launch cost reductions are predicted. From these projections the performances necessary for future solar and nuclear space power options are identified. The availability of plentiful cost effective electric power and of low cost access to space are identified as crucial factors in the future extension of human presence in space. ESA

N90-17696# Aerospatiale, Cannes (France).
THE 25 kWe SPACEBORNE SOLAR DYNAMIC GENERATOR
F. Andrieux and L. Pelenc *In* ESA, European Space Power, Volume 1 Aug. 1989 p 137-142 (For primary document see N90-17678 10-20)
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Research is presented comparing photovoltaic, solar dynamic and nuclear electric power generating techniques. It is concluded that a solar dynamic system associated with thermal storage is competitive in terms of performance (20 percent global efficiency, 10 W/kg power to weight ratio) The system constituents, concentrator, receiver, storage, thermodynamic cycle, alternator and radiator are discussed. Design, performance and critical items are defined. The most critical aspects, which are the receiver and the thermal storage concept, are discussed in detail. ESA

N90-17697# Commissariat a l'Energie Atomique, Gif-sur-Yvette (France). Centre d'Etudes Nucleaires.
CNES-CEA COMPARATIVE EVALUATION STUDY OF VARIOUS CANDIDATE 20 kWe SPACE POWER SYSTEMS
F. Carre, E. Proust, and P. Keirle *In* ESA, European Space Power, Volume 1 Aug. 1989 p 143-149 (For primary document see N90-17678 10-20)
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A preliminary comparison study between radioisotopic, solar, and nuclear space power systems likely to supply 20 kWe in high

earth orbit is presented. The criteria considered for this comparison include, launch safety, mass performance, operational reliability, integration with the launch vehicle, and estimated development and recurrent costs. The most promising candidates emerging from the study are the solar photovoltaic generator with AsGa cells and nickel/hydrogen batteries, and the nuclear power system. The major assets of the solar photovoltaic generator relate mainly to the absence of specific risk in case of launch abort and reentry into the atmosphere. The major advantages of the nuclear power system include autonomous operation, large scaling potential, and a recurrent cost estimated at 20 percent of that of an equivalent 20 kWe solar photovoltaic generator. ESA

N90-17698# European Space Agency. European Space Research and Technology Center, ESTEC, Noordwijk (Netherlands).
DESIGN CONSIDERATIONS AND LESSONS LEARNED ON THE EUROPEAN RETRIEVABLE CARRIER
Henri vanLooij *In its* European Space Power, Volume 1 Aug. 1989 p 151-154 (For primary document see N90-17678 10-20)
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The electrical power system considerations involved in designing the EUropean REtrievable CArrier (EURECA) are described. The choice between an unregulated battery bus and a regulated bus is discussed. The reasons for having a separate battery charging solar array, and for problems occurring during use of the low-power waiting-phase are outlined. ESA

N90-17699# Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).
THE MECB DATA COLLECTING SATELLITE POWER SUPPLY SUBSYSTEM
C. F. S. Freire and M. C. P. Almeida *In* ESA, European Space Power, Volume 1 Aug. 1989 p 155-158 (For primary document see N90-17678 10-20)
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The power supply subsystem of the first Brazilian satellite is described. This satellite is intended to be the first of a series of four satellites included in the Brazilian Complete Space Mission (MECB) program. A regulated main bus concept was chosen based on system level constraints and future designs. The subsystem equipment responsible for power conditioning, power distribution and protection is described. The equipment responsible for electrical power generation and storage is described. ESA

N90-17700# McDonnell-Douglas Corp., Saint Louis, MO.
THE MODULAR POWER SUBSYSTEM
Michael J. Mackowski *In* ESA, European Space Power, Volume 1 Aug. 1989 p 159-164 (For primary document see N90-17678 10-20)
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A modular spacecraft electrical power processing and energy storage system with a load capability of over one kilowatt is described. Built, tested, and now in use on several low earth orbit satellites, the modular power subsystem (MPS) conditions energy received from an appropriately-sized solar array for distribution to other spacecraft modules, to the payloads, and for recharging nickel cadmium batteries. A peak power tracking circuit in the power conversion electronics is used to maximize the energy drawn from the solar array. Power requirements from 250 to 1200 watts can be satisfied by the MPS and techniques for combining the outputs of several MPS modules are under development. ESA

N90-17701# Ford Aerospace and Communications Corp., Palo Alto, CA. Space Systems Div.
SPACE STATION FREEDOM ENERGY STORAGE SYSTEM DESIGN AND DEVELOPMENT
R. J. Haas and C. W. Koehler *In* ESA, European Space Power, Volume 1 Aug. 1989 p 169-172 (For primary document see N90-17678 10-20)
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The NASA Space Station Freedom 75 kW energy storage system using nickel hydrogen (Ni-H2) batteries to provide electrical power during eclipse and peak load operation is described. The 81-Ah battery cells are designed for a five year life in low earth orbit (LEO) with a 35 depth-of-discharge. The batteries consist of 30 individual pressure vessel (IPV) cells enclosed in an orbital replaceable unit (ORU). The basic cell, battery and ORU design, development and production are described. The key system design issues include the mechanical and thermal interfaces for both the battery and the ORU assembly. Verification plans for the mission critical components such as the nickel electrode and Inconel 718 pressure vessel are discussed. ESA

N90-17702# MATRA Espace, Toulouse (France).
ELECTRICAL BATTERY MODEL FOR LEO APPLICATION BASED ON ABSOLUTE INSTANTANEOUS STATE OF CHARGE **c33**
A. Lehman *In* ESA, European Space Power, Volume 1 Aug. 1989 p 173-178 (For primary document see N90-17678 10-20)
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A working Ni-Cd electrical battery model derived from ground experimentation for low earth orbit (LEO) applications is described. The validity of the model is demonstrated over a wide range of depth of discharge and temperatures. The model, developed from observation of the electrical behavior of cells as a function of their absolute instantaneous state of charge, is fine tuned and validated with a high degree of accuracy. The simulation model may be applied to the analysis of other types of cells, either of different capacities or manufacture. ESA

N90-17703# Societe des Accumulateurs Fixes et de Traction, Romainville (France).
MATHEMATICAL MODELLING AND EXPERT SYSTEM FOR BATTERY MANAGEMENT **c33**
Jacques Boscher, Pascal Marrot, and Karim Bouridah (European Space Agency. European Space Research and Technology Center, ESTEC, Noordwijk, Netherlands) *In* ESA, European Space Power, Volume 1 Aug. 1989 p 179-185 (For primary document see N90-17678 10-20)
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The GIBUS expert system, designed to improve management of batteries on board satellites by test center operators, is described. The long term prospects of the project are the development of an operators support system at ground based control centers managing on-satellite storage batteries. An on-board self-management system is suggested as a possible extension of the program. ESA

N90-17704# Danish Research Center for Applied Electronics, Hoersholm.
THERMAL STUDY OF BATTERY CHARGE CONTROL BY TEMPERATURE DERIVATIVE REDUCTION **c33**
P. HalkjaerJacobsen, K. A. Schmidt, S. Otto, G. J. Dudley, and H. J. N. Spruijt (European Space Agency. European Space Research and Technology Center, ESTEC, Noordwijk, Netherlands) *In* ESA, European Space Power, Volume 1 Aug. 1989 p 187-192 (For primary document see N90-17678 10-20)
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A battery charge control technique, invented at ESTEC in 1983, which relies upon the changes in the battery cell temperature time derivative which accompany the onset of overcharge is described. A thermally realistic portion of a typical flight battery is constructed and tested in parallel with detailed thermal modeling in order to develop the technique further. Comparisons between thermal model and test results are presented and show satisfactory agreement. Optimum positions for the temperature sensors within the battery are identified, taking into account sensitivity to cell temperature changes as well as to thermal perturbations due to external effects. ESA

N90-17705# British Aerospace Public Ltd. Co., Stevenage (England). Space Systems Div.
THE GROUND TESTING OF NICKEL HYDROGEN BATTERIES PRIOR TO LAUNCH **c33**
B. D. Cox and P. Leggett (European Space Agency. European Space Research and Technology Center, ESTEC, Noordwijk, Netherlands) *In* ESA, European Space Power, Volume 1 Aug. 1989 p 193-199 (For primary document see N90-17678 10-20)
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Results of ground testing of a nickel hydrogen battery are presented. Improvements in the basic packaging of the battery in order to optimize in-orbit and ground testing are suggested. The ground test results are parameterized to show the effect of the thermal characteristics of the cells, which are designed to ensure optimum operation in the space environment encountered after launch. A correlation system is developed to extrapolate the ground test results obtained for the batteries to test results that would be obtained in a space environment. ESA

N90-17706# Dornier System G.m.b.H., Friedrichshafen (Germany, F.R.).
THE HERMES FUEL CELL POWER PLANT
H. Gehrke and U. Knoebel *In* ESA, European Space Power, Volume 1 Aug. 1989 p 203-209 (For primary document see N90-17678 10-20)
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An overview of the technical status of the Hermes fuel cell power plant development program is presented. The results of a 1988 selection study to find the most promising fuel cell technology are described. The characteristics of the immobile system chosen as best suited for space applications are outlined. A development schedule for the overall Hermes project is presented. ESA

N90-17707*# Los Alamos National Lab., NM. Advanced Engineering Technology Group.
ADVANCED SPACE POWER PEM FUEL CELL SYSTEMS
N. E. Vanderborgh, J. Hedstrom, and J. R. Huff *In* ESA, European Space Power, Volume 1 Aug. 1989 p 211-216 Sponsored by NASA, Lewis Research Center and DOE, Morgantown, WV (For primary document see N90-17678 10-20)
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A model showing mass and heat transfer in proton exchange membrane (PEM) single cells is presented. For space applications, stack operation requiring combined water and thermal management is needed. Advanced hardware designs able to combine these two techniques are available. Test results are shown for membrane materials which can operate with sufficiently fast diffusive water transport to sustain current densities of 300 ma per square centimeter. Higher power density levels are predicted to require active water removal. ESA

N90-17708*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
REGENERATIVE FUEL CELL SYSTEMS FOR PROJECT PATHFINDER
J. R. Huff, J. Hedstrom, N. E. Vanderborgh (Los Alamos National Lab., NM.), and P. Prokopius *In* ESA, European Space Power, Volume 1 Aug. 1989 p 217-219 (For primary document see N90-17678 10-20)
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The objectives of a surface power program, an element of the exploration thrust of the Pathfinder project, and plans for meeting them are outlined. Technological assessment and tradeoff studies of fuel cell and electrolyzer technologies suitable for use in a regenerative fuel cell are described. The viability of proton exchange membranes (PEM) in meeting the system requirements is discussed. ESA

N90-17709# European Space Agency. European Space Research and Technology Center, ESTEC, Noordwijk (Netherlands).
EUROPEAN REGENERATIVE FUEL CELL TECHNOLOGY FOR SPACE USE
Francis Baron, Ralf Philippi, and Werner Tillmetz (Dornier System G.m.b.H., Friedrichshafen, Germany, F.R.) *In its* European Space Power, Volume 1 Aug. 1989 p 221-226 (For primary document see N90-17678 10-20)
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The results of two studies within the framework of the European regenerative fuel cell system research program are presented. Four different technologies are considered: the immobile alkaline electrolyte system, the proton exchange membrane system, mixed systems with these solutions, and the mobile alkaline electrolyte system. A comparison of the different systems concerning their application in space is given. Emphasis is laid on the comparison of performance, efficiency and mass of the systems. The immobile alkaline electrolyte system is shown to present several advantages within those parameters. ESA

N90-17710# United Technologies Corp., Windsor Locks, CT.
HYDROGEN/OXYGEN SPE (TRADEMARK) ELECTROCHEMICAL DEVICES FOR ZERO-G APPLICATIONS
Andrei Leonida *In* ESA, European Space Power, Volume 1 Aug. 1989 p 227-231 (For primary document see N90-17678 10-20)
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Hydrogen-oxygen-water SPE (registered trademark) electrochemical systems which could be used to integrate life support, propulsion and energy storage functions for future space programs are described. The performance of two passive fluid management electrochemical cells is discussed. One is an electrolyzer which has separate water and product gas compartments and generates liquid free gases. The second is a fuel cell device which effects the water separation and removal internally without moving parts. Passive fluid management makes the designs of interest for zero-G applications. The proof-of-concept testing was done on Earth. The cell orientation was such that the effect of gravity was negligable. A unitized design combining the electrolyzer and fuel cell capabilities in a single cell for energy conversion and storage is discussed. ESA

N90-17711# Dornier System G.m.b.H., Friedrichshafen (Germany, F.R.).
SIMULATION OF REGENERATIVE FUEL CELL SYSTEMS INCLUDING THERMAL CONTROL
Ralf Simon and Markus Rothmeyer *In* ESA, European Space Power, Volume 1 Aug. 1989 p 233-238 Sponsored in part by ESA (For primary document see N90-17678 10-20)
Copyright Avail: NTIS HC A19/MF A03

Flexible simulation and analysis software for system development and engineering of regenerative fuel cell systems is presented. The modular simulation program is based on a simulation program for the Hermes fuel cell system. All the major parameters influencing component or system performance are taken into account: temperature, heat and mass flow, chemical reactions, electrical interfaces and thermal control logic. Transient results of simulation runs are shown. The general design, input and output capabilities and future extensions and applications of the system are discussed. ESA

N90-17712# Technische Univ., Graz (Austria).
WATER REMOVAL STUDIES ON HIGH POWER HYDROGEN-OXYGEN FUEL CELLS WITH ALKALINE ELECTROLYTES **c33**
K. Kordesch, J. C. T. Oliveira, Ch. Gruber, and G. Winkler *In* ESA, European Space Power, Volume 1 Aug. 1989 p 239-244 Sponsored by the Austrian Fonds zur Foerderung der Wissenschaftlichen and CNPq, Brazil (For primary document see N90-17678 10-20)
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Research in verification of bipolar fuel cell design, containing

mass-produceable all-carbon electrodes which can be used in alkaline or acidic cells with liquid or immobilized (matrix) electrolytes, is described. Spin-offs from the research related to the Hermes manned spaceplane could be useful for applications on Earth. Peak-power plants, electric vehicles and storage devices used in combination with renewable energy sources could all benefit from the research. A subsequent investigation of water transpiration properties of carbon electrodes is described. ESA

N90-17713# Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires.

SOLID POLYMER ELECTROLYTE WATER ELECTROLYSIS AS A MEAN OF ENERGY STORAGE FOR SPACE APPLICATIONS **c44**

P. Millet, T. Alleau, P. Mathonnet, M. Pineri, and R. Durand (Centre de Recherche en Electrochimie Minerale et en Genie des Procedes, Saint Martin-d'Heres, France) *In* ESA, European Space Power, Volume 1 Aug. 1989 p 245-249 (For primary document see N90-17678 10-20)

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Research in the development of a solid polymer electrolyte water electrolysis regenerative fuel cell system is presented. Results concerning the preparation of membrane-electrode assemblies are presented. Life tests performed on lab-scale samples show that the electrochemical performance can be maintained over 15,000 hours of continuous electrolysis without any problem. A filter-press type electrolyzer is designed and constructed. Electrochemical test results of the electrolyzer are presented. ESA

N90-17714# Marconi Space Systems Ltd., Portsmouth (England).

NICKEL HYDROGEN CELL DESIGN FOR SPACE APPLICATIONS

J. M. Harvey *In* ESA, European Space Power, Volume 1 Aug. 1989 p 253-258 (For primary document see N90-17678 10-20)

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A number of different nickel hydrogen cells for space applications are presented. These include a 50AH Independent Pressure Vessel (IPV) cell designed for use in Geostationary Earth Orbit (GEO) satellites, an independent pressure vessel cell designed for use in Low Earth Orbit (LEO) satellites and a Common Pressure Vessel (CPV) dual nickel hydrogen cell for use in low earth orbit satellites. The 50AH GEO cell is subjected to comprehensive mechanical and thermal analysis to establish a spaceworthy product. The cell electrical performance is confirmed by testing under various typical charge/discharge conditions and at various temperatures. Cycle life testing is carried out. A similar program is under way for the IPV LEO cell. The dual CPV cell is taken to the hardware proving stage and electrical and mechanical test results are described. ESA

N90-17715# Societe des Accumulateurs Fixes et de Traction, Romainville (France). Dept. of Aerospace.

STATUS OF THE CYCLING TESTS PERFORMED WITH SAFT NiH2 CELLS DEDICATED TO SPACE APPLICATIONS

O. Puig and T. Jamin (Centre National d'Etudes Spatiales, Toulouse, France) *In* ESA, European Space Power, Volume 1 Aug. 1989 p 259-264 (For primary document see N90-17678 10-20)

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Life tests carried out on SAFT (company name) Ni-H2 cells for geostationary and low earth orbit applications are described. The effect of different parameters on the electrical performance of the cells is described. Results of these tests suggest that for low earth orbit applicatins, the cell lifetime is highly dependent on the charge control method. Cell performance in geostationary orbit is sensitive to reconditioning. The K factor and floating current improve the cell performance. In both geostationary and low earth orbit, the performance of the cells decreases very slowly. ESA

N90-17716# European Space Agency. European Space Research and Technology Center, ESTEC, Noordwijk (Netherlands).

LOW EARTH ORBIT NICKEL CADMIUM BATTERY LIFETIME TESTING **c33**

B. Hendel and G. J. Dudley *In its* European Space Power, Volume 1 Aug. 1989 p 265-270 (For primary document see N90-17678 10-20)

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The status of the ongoing lifetime tests of NiCd batteries cycling under low earth orbit conditions is described. Most of the batteries have been cycling for four years under low earth orbit conditions at the ESTEC battery test center. End of charge and discharge voltages as a function of cycles, temperature, depth of discharge, and the presence or absence of six-monthly capacity checks is presented. Comparisons are made between the behavior observed with simple charge-discharge cycling regimes and that observed for a battery subjected to a realistic power profile expected for the earth observation satellite ERS-1. ESA

N90-17717# Societe des Accumulateurs Fixes et de Traction, Romainville (France). Dept. of Aerospace.

PRELIMINARY STUDY OF RECHARGEABLE LITHIUM CELLS FOR SPACE APPLICATIONS

Jean Labat and Jacques Goualard *In* ESA, European Space Power, Volume 1 Aug. 1989 p 271-274 Sponsored by CNES (For primary document see N90-17678 10-20)

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Research carried out on lithium rechargeable cells using on organic electrolyte and intercalation compounds is described. Metal oxides such as V2O5, MoO3, and MoV2O8 are investigated as possible cathode materials. V2O5 shows the most potential of the three. Preliminary development cells, C size, having an energy density of 80 to 140 Wh/kg in the voltage range of 3.4 to 2.2 volt are tested in cycling conditions simulating space applications. More than 80 cycles at 100 percent of discharge of the upper voltage plateau are sustained. Charge retention is measured in a temperature range of 0 to 40 C. Possible applications of lithium cell technology in space missions are reviewed. ESA

N90-17718# Ballard Battery Systems, Vancouver (British Columbia).

A LITHIUM SULPHUR DIOXIDE CELL FOR DEEP SPACE APPLICATIONS

L. S. Marcoux, C. E. Newnham, and J. Verniolle (European Space Agency. European Space Research and Technology Center, ESTEC, Noordwijk, Netherlands) *In* ESA, European Space Power, Volume 1 Aug. 1989 p 275-279 (For primary document see N90-17678 10-20)

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The development of a long life, high energy density D size lithium sulfur dioxide cell for deep space applications is described. Although designed with the requirements of the ESA Titan probe battery in mind, the program requirements are made sufficiently broad in order that the cell could be considered for other future deep space missions. Effort is focussed on improving several key features of a commercial Li/SO2 cell, namely high rate low temperature performance, cell capacity pulse capability and resilience to mechanical environments such as vibration, acceleration and shock. The results of these tests are presented. ESA

N90-17719# Dornier System G.m.b.H., Friedrichshafen (Germany, F.R.).

OPTIMIZED SENSIBLE HEAT STORAGE SYSTEMS FOR APPLICATION TO SOLAR DYNAMIC POWER GENERATION **c44**

W. J. Denner, A. A. Fritzsche, and P. Jany *In* ESA, European Space Power, Volume 1 Aug. 1989 p 281-286 (For primary document see N90-17678 10-20)

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The transient behavior of a sensible heat storage system is

investigated numerically. With a counterflow scheme and a matrix of BeO-spheres, a thermal efficiency of 98.5 percent and almost constant fluid outlet temperature during 85 percent of discharge time are obtained, proving the potential of this storage alternative for application to solar dynamic power generation in space. Some preliminary results of the overall system simulation, comprising the storage, induced transient behavior of turbine, radiator etc. indicate that the electrical power output can be kept constant within a few percent. ESA

N90-17720# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Stuttgart (Germany, F.R.). Inst. fuer Technische Thermodynamik.

DEVELOPMENT OF A HIGH TEMPERATURE STORAGE UNIT FOR INTEGRATION WITH SOLAR DYNAMIC SYSTEMS **c44**

H. J. Staehle and F. Lindner *In* ESA, European Space Power, Volume 1 Aug. 1989 p 287-291 (For primary document see N90-17678 10-20)

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Lithium fluoride in its capacity as a suitable energy storage material is investigated. Energy is stored as latent heat by melting the LiF. The energy is later released during recrystallization of the salt. Drawbacks to this system are described. The high corrosivity in molten state may lead to container failure in long term use. In order to avoid destruction of canisters, a graphite container is developed as graphite is not wetted by liquid LiF and thus does not suffer any corrosion. In order to match the mechanical forces caused by the volume increase during melting, a channel-like internal structure is tested. The melt formed first can expand into these channels and no pressure is built up. The results of these tests are presented. ESA

N90-17721# Technische Univ., Delft (Netherlands). Lab. for Power Electronics.

PWM CONVERTER TOPOLOGIES **c33**

E. R. W. Meerman and H. J. N. Spruyt (European Space Agency. European Space Research and Technology Center, ESTEC, Noordwijk, Netherlands) *In* ESA, European Space Power, Volume 1 Aug. 1989 p 297-305 (For primary document see N90-17678 10-20)

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Dc to dc converters using an electrical switch to control power flow between a dc source and a dc load are discussed. Only Pulse Width Modulation (PWM) type converter topologies are considered. A basic three element, three terminal converter topology is defined followed by two universal rules allowing for derivation of a wide variety of different topologies. A summary of different topology types is provided with steady state and small signal relations given for each. The survey shows 46 converter topologies of which 18 are known and 28 are new (under, patent application). The number of topologies could be increased to 68 if negative input voltages are considered. ESA

N90-17722# Ecole Nationale Superieure de Mecanique et d'Aerotechnique, Poitiers (France).

APPLICATION OF A BUCK-TYPE MC2 REGULATED CONVERTER FOR A STEPPER MOTOR CONTROL **c33**

M. deColigny, L. J. Dullaart, R. Rodriguez (SEEP Engineering, France), M. Capdepuy, A. Capel, and A. Battle *In* ESA, European Space Power, Volume 1 Aug. 1989 p 307-309 (For primary document see N90-17678 10-20)

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Stepper Motor Control (MC) using twin bidirectional buck converters is presented. The system can be split in two by providing digital electronics for the generation of sine reference voltages with variable frequency, or by means of analog electronics using two buck regulators, each followed by an inverter bridge that drives the stepper motor. The sine reference with variable frequency is used to avoid vibrations on the motor axis. The digital circuit outputs its data via a digital to analog converter that gives the rectified value and sign of the sinusoidal signals to the buck converters of the analog part and bridge-inverter which allows for a bipolar motor current. ESA

N90-17723# Centre National d'Etudes Spatiales, Toulouse (France).

CURRENT PROTECTIONS MODELISATION IN A BUCK CELL **c33**

A. Barnaba *In* ESA, European Space Power, Volume 1 Aug. 1989 p 311-316 (For primary document see N90-17678 10-20)

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Two modes of current protection and their implementation in a buck switching cell with input filter are presented. For one mode, (overloading or short circuit), the input current is maintained constant. For the other mode the output current is maintained constant. These two modes are satisfied with analog circuitry which highlights the effect of the current or voltage threshold stop on the operation of the regulation loops. ESA

N90-17724# Fabrica Italiana Apparecchiature Radioelettriche S.p.A., Milan.

THE 120V 20A PWM SWITCH FOR APPLICATIONS IN HIGH POWER DISTRIBUTION **c33**

V. Borelli and W. Nimal (Etudes Techniques et Constructions Aerospatiales, Charleroi, Belgium) *In* ESA, European Space Power, Volume 1 Aug. 1989 p 317-321 (For primary document see N90-17678 10-20)

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A 20A/120VDC (voltage direct current) PWM (Pulse Width Modulation) Solid State Power Controller (SSPC) developed under ESA contract to be used in the power distribution system of Columbus is described. The general characteristics are discussed and the project specification defined. The benefits of a PWM solution over a more conventional approach, for the specific application considered are presented. An introduction to the SSPC characteristics and a functional description are presented. ESA

N90-17725# European Space Agency. European Space Research and Technology Center, ESTEC, Noordwijk (Netherlands).

MAGNETIC COUPLED CURRENT SENSING TECHNIQUES FOR SPACECRAFT POWER SYSTEMS

L. Ghislanzoni *In its* European Space Power, Volume 1 Aug. 1989 p 323-327 (For primary document see N90-17678 10-20)

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A simple technique suitable for current sensing in spacecraft power systems is described. A review of existing magnetic coupled current sensors is presented. An alternative approach which needs very simple electronics and yet equals the performances of more sophisticated devices is described. Problems overcome by the technique are described including the high impedance value, which for applications such as zero ripple dc/dc converters, must be as low as possible, and core losses that dramatically restrict the choice of available magnetic materials. ESA

N90-17726# Loughborough Univ. of Technology (England).

AN ASSESSMENT OF THE USE OF RESONANT-MODE TOPOLOGIES FOR HIGH FREQUENCY POWER CONVERSION **c33**

S. H. Weinberg and C. D. Manning *In* ESA, European Space Power, Volume 1 Aug. 1989 p 331-337 (For primary document see N90-17678 10-20)

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The switching of power MOSFET (metal oxide semiconductors field effect transistors) at high frequencies is examined in the light of the advantages and disadvantages experienced when using resonant-mode topologies. With careful choice of topologies appropriate to application areas, many disadvantages may be avoided. A comprehensive account of the available resonant mode topologies is presented. A categorization of these topologies according to their characteristic advantages and disadvantages is given. This is supplemented by a comprehensive list of references. ESA

N90-17727# Universidad de Oviedo, Gijon (Spain). Dept. de Ingenieria Electrica, Electronica, Computadores y Sistemas.
A NEW VISION TO MODEL THE PARALLEL RESONANT CONVERTER **c33**
M. Rico, J. Sebastian, J. Uceda (Universidad Politecnica de Madrid, Spain), and M. A. Perez *In* ESA, European Space Power, Volume 1 Aug. 1989 p 339-344 (For primary document see N90-17678 10-20)
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A resonant converter model is proposed. The parallel resonant converter is analyzed and conclusions are drawn. An average static and dynamic equivalent circuit is derived. Peak resonant capacitor voltage and inductor current are plotted. The theoretical results are compared with those obtained from experiments carried out on a prototype. ESA

N90-17728# Escuela Tecnica Superior de Ingenieros Industriales, Gijon (Spain). Dept. de Ingenieria Electrica y Electronica.
DESIGN OF A POWER SUPPLY SYSTEM BASED IN TWO QUASI-RESONANT CONVERTERS **c33**
M. A. Perez, J. Sebastian, J. Uceda, F. Nuno, J. A. Martinez, and J. Cezon (INISEL, Torrejon de Ardoz, Spain) *In* ESA, European Space Power, Volume 1 Aug. 1989 p 345-350 (For primary document see N90-17678 10-20)
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The design of dc to dc resonant converters used as power supplies in a laser system are described. Both converters belong to the ZCS-QRC (zero current switched quasi resonant converters) family. The first works with a pulsed load. The second is a three-output converter. Test results of both converters are presented. ESA

N90-17729# Loughborough Univ. of Technology (England).
TECHNIQUES FOR HIGH FREQUENCY POWER CONVERSION **c33**
S. H. Weinberg and C. D. Manning *In* ESA, European Space Power, Volume 1 Aug. 1989 p 351-356 (For primary document see N90-17678 10-20)
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The use of high speed driving of power MOSFETs (metal oxide semiconductors field effect transistors) for high power density power conversion is discussed. Switching frequencies of 500 kHz and above have called for new techniques in all areas of power converter design. MOSFET and diode switching losses, high frequency magnetic materials and core losses, skin and proximity effects are discussed as means of optimizing power converter design. Parasitics, thermal design, cooling, and the effects of noise are discussed. ESA

N90-17730# Gdansk Technical Univ. (Poland). Inst. of Electronic Technology.
DYNAMICAL MODEL OF SERIES-RESONANT CONVERTER WITH PEAK CAPACITOR VOLTAGE PREDICTOR AND SWITCHING FREQUENCY CONTROL **c33**
A. Pietkiewicz, D. Tollik, and J. B. Klaassens (Technische Univ., Delft, Netherlands) *In* ESA, European Space Power, Volume 1 Aug. 1989 p 357-360 (For primary document see N90-17678 10-20)
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A simple small-signal low-frequency model of an idealized series resonant converter employing peak capacitor voltage prediction and switching frequency control is proposed. Two different versions of the model describe all possible conversion modes. It is found that step down modes offer better dynamic characteristics over most important network functions than do the step-up modes. The dynamical model of the series resonant converter with peak capacitor voltage prediction and switching frequency programming is much simpler than such popular control stategies as frequency VCO (voltage controlled oscillators) based control, or diode conduction angle control. ESA

N90-17731# TRW Systems Group, Redondo Beach, CA. Space and Technology Group.
INNOVATIONS IN THE DESIGN AND MATCHING OF MAGNETIC COMPONENTS AND SEMICONDUCTORS UP PERFORMANCE AND RELIABILITY OF POWER CONVERTERS **c33**
H. E. Gavira *In* ESA, European Space Power, Volume 1 Aug. 1989 p 361-366 (For primary document see N90-17678 10-20)
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Refinements in various types of magnetic components and their synthesis in high frequency switched mode power converters, including several innovative configurations, are presented. One of these configurations effectively reduces the parasitic reset inherent in saturable-core output regulators. This is done by combining two techniques, the use of passive components, and performing the design of the saturable-core component in a multi-filar fashion such that it also performs the function of a linear transformer at the time the rectifiers go through their reverse recovery transient. Experimental results demonstrate how these techniques in the design of magnetic components can improve the performance and reliability of both the circuit elements they directly interface with and those of the overall power converter. Another novel configuration is a stable high frequency transformer oscillator with a 2-milligram saturable core. Unique matching of magnetic components and MOSFET (metal oxide semiconductors field effect transistors) devices by the oscillator is demonstrated. ESA

N90-17732# Mitsubishi Electric Corp., Kamakura (Japan).
POWER PROCESSING UNIT FOR 20mN-CLASS ION ENGINE SYSTEM
H. Osuga, K. Masuo, T. Gohnai, T. Okamura, and I. Terukina *In* ESA, European Space Power, Volume 1 Aug. 1989 p 367-372 (For primary document see N90-17678 10-20)
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The 20mN-class ion engine system to be mounted on geosynchronous satellites is described. The system requires stabilized electric power of 700 W to ionize the propellant and accelerate the ions. The electric power is supplied by the Power Processing Unit (PPU) designed for efficient power conversion, minimal volume to weight ratios and to suppress electromagnetic interference. The PPU employs a vector-combined dc to dc voltage resonant converter. This PPU is more than 87 percent efficient. The design of the PPU and of the voltage converter are outlined. ESA

N90-17733# Escuela Tecnica Superior de Ingenieros de Telecomunicacion, Barcelona (Spain).
LINEAR AND NON-LINEAR CONTROL OF HIGH-ORDER CONVERTERS AFTER REDUCING THE ORDER BY APPROPRIATE TECHNIQUES **c33**
A. Poveda, L. Martinez, J. Majo, L. GarciadeVicuna, F. Guinjoan, and M. Valentin (Laboratoire d'Automatique et d'Analyse des Systemes, Toulouse, France) *In* ESA, European Space Power, Volume 1 Aug. 1989 p 375-380 (For primary document see N90-17678 10-20)
(Contract AIHF-183)
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The dynamic behavior of a coupled-inductor converter in constant frequency current-programmed mode is analyzed using averaging techniques. In the continuous conduction mode, a small signal model is obtained in the form of a control to output transfer function. The conditions necessary for a first-order response are identified. Under conditions of order reduction, a non-linear control of the coupled-inductor converter, suitable for large signal applications is presented. ESA

N90-17734# Pisa Univ. (Italy). Inst. of Electricity.
VARIABLE STRUCTURE CONTROL SYSTEM APPLIED TO MULTILEVEL POWER CONDITIONING CONVERTERS **c33**
D. Casini, M. Marchesoni, and L. Puglisi (Genoa Univ., Italy) *In* ESA, European Space Power, Volume 1 Aug. 1989 p 381-388

(For primary document see N90-17678 10-20)
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A control technique devised to obtain high dynamic responses from a multilevel power conditioning converter is presented. A variable structure system with sliding mode is followed, taking into account problems that may be encountered in space environments. The analytical data provides general tools for ac power conditioning systems design. The control scheme, its mathematical analysis and digital simulation results relevant to a 115 V/400 Hz ac power system are presented and discussed. ESA

N90-17735# Alcatel Espace, Toulouse (France).
STATE VARIABLE MODELLING FOR THE AUDIOSUSCEPTIBILITY EVALUATIONS OF CURRENT CONTROLLED ZERO RIPPLE STRUCTURES **c33**
A. Capel and J. C. Marpinard (Laboratoire d'Automatique et d'Analyse des Systemes, Toulouse, France) *In* ESA, European Space Power, Volume 1 Aug. 1989 p 389-397 (For primary document see N90-17678 10-20)
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Development of a state variable model for the dynamic analysis of current controlled power structures is described. Validation of the model is demonstrated on a specific case. The model is compared with the disturbed inductor current model. The application of the model to the zero ripple MC2 (motor control) buck power cell is discussed. ESA

N90-17736# Laboratoire d'Automatique et d'Analyse des Systemes, Toulouse (France).
HIGH SPEED DIGITAL CONTROL OF HIGH FREQUENCY PWM CONVERTERS **c33**
J. C. Marpinard, P. Bidan, and J. M. Hernandez (Centro de Ensenanza Tecnica Industrial, Guadalajaro, Mexico) *In* ESA, European Space Power, Volume 1 Aug. 1989 p 399-402 (For primary document see N90-17678 10-20)
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A technique for obtaining digital PWM (pulse width modulation) high frequency modulation in large signal operations is presented. Nonlinear state feedback control techniques introduced by Valentin (1984) have proved to be a great improvement for large signal operation of dc/dc or dc/ac converters. Unfortunately, analog implementation of nonlinear control loops is complex and highly difficult to set up. Digital implementation of these loops can be achieved but the use of high frequency PWM prohibits complex real time calculations with microprocessors. The proposed solution consists of a previous off line calculation and record of the dynamic switch duty ratio corresponding to the control loop. The main interest of this control technique is its extreme flexibility. It allows simple development of sophisticated nonlinear control loops. ESA

N90-17737# Technische Univ., Vienna (Austria). Power Electronics Section.
COMPARISON OF CONTROL STRUCTURES FOR A BIDIRECTIONAL HIGH-FREQUENCY dc-dc CONVERTER **c33**
Felix A. Himmelstoss, Johann W. Kolar, and Franz C. Zach *In* ESA, European Space Power, Volume 1 Aug. 1989 p 403-408 Sponsored by the Austrian Fonds zur Foerderung der Wissenschaftlichen (For primary document see N90-17678 10-20)
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A system for dc-dc power conversion based on a buck-boost converter topology is presented. It makes power flow in both directions possible. The possibility of bidirectional power flow is useful for certain applications, such as uninterruptable power supplies. Starting from a structural diagram the transfer function of the system is derived. The controller for the converter is then designed. It is made up of a simple voltage controller, a voltage controller with an inner loop current controller (cascade control) and with two kinds of state space control. The transfer functions of the different system parts are derived and dimensioning guidelines for the controller sections are presented. The closed loop behavior of the bidirectional converter for the different control structures is analyzed based on simulation using duty cycle averaging. Bodediagrams and step responses are shown. ESA

N90-17738# Politecnico di Milano (Italy).
ANALYSIS OF THE CUK CONVERTER IN DELTA V MODE BY CHARGE AND FLUX BALANCES **c33**
P. Maranesi, L. Pinola, V. Varoli, and G. F. Volpi (LABEN Ferranti International, Vimodrone, Italy) *In* ESA, European Space Power, Volume 1 Aug. 1989 p 409-413 (For primary document see N90-17678 10-20)
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A technique for small signal modeling of switched power processors is applied to a Cuk dc/dc converter in the incremental voltage control mode (delta V mode). The vector of the electric charges and magnetic fluxes is assumed to be the state vector. Relevant transition matrix A, input matrix B and output matric C are derived. According to the state space description in Z transform, the converter is characterized, with its external loop open. Theoretical versus experimental results are compared and good compliance is found between the two. ESA

N90-17739# European Space Agency. European Space Research and Technology Center, ESTEC, Noordwijk (Netherlands). Power and Energy Conversion Division.
SIMPLE POLE/ZERO MODELLING OF CONDUCTANCE CONTROLLERS **c33**
D. OSullivan and A. Crausaz *In its* European Space Power, Volume 1 Aug. 1989 p 415-423 (For primary document see N90-17678 10-20)
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The design analysis of a PWM (pulse width modulation) conductance controller is expanded to predict certain key performance functions of the regulator. These include the input-to-output voltage susceptibility. Input impedance, closed and open loop response, and output impedance. The method used consists of the derivation of the exact polynomial for each of the functions, including the pole/zero representation of the amplifiers. The functions are analyzed and simplified to derive equivalent pole/zero representations for these functions. The resultant pole/zero representation gives the designer a clearer understanding of the importance of each design parameter on the functions to be analyzed and hence, shows where improved performance can be achieved. A result of this analysis shows that the input impedance of a conductance controlled regulator is damped, in a similar manner to the damping exhibited in the conductance control function. ESA

N90-17740# CONACyT, Cuernavaca (Mexico).
MODELLING THE BUCK-TYPE CONVERTER TRANSIENT RESPONSE WITH PULSATING LOAD **c33**
J. Arau, J. Cezon, F. Aldana, and J. Uceda (Universidad Politecnica de Madrid, Spain) *In* ESA, European Space Power, Volume 1 Aug. 1989 p 425-432 (For primary document see N90-17678 10-20)
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The analysis and modeling of buck type converters is described. Load variations are considered like any other variable in the system. Continuous time models which enable prediction of the transient response of the converter are proposed. Practical results are presented to validate analytical predictions derived from the model. The proposed method can be used in other dc-dc converter topologies. ESA

N90-17741# Alcatel Espace, Toulouse (France).
A COMPLETE EPC SIMULATION **c33**
C. Peyrotte and J. Y. Lebas *In* ESA, European Space Power, Volume 1 Aug. 1989 p 435-441 (For primary document see N90-17678 10-20)
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A simulation program for a complete Electric Power Converter (EPC) (the power source which provides regulated high voltages to a traveling wave tube) is presented. The EPC consists of two

separate voltage converters. The simulation of the EPC architecture is compared to corresponding breadboard test results. A good correlation between the as built and the as modelized EPC is demonstrated. ESA

N90-17742# BBN Communications A/S, Ballerup (Denmark).
LOW NOISE, HIGH VOLTAGE SUPPLY FOR CARCINOTRON BACKWARD WAVE OSCILLATORS **c33**
F. H. Pedersen and J. C. J. Eeman (European Space Agency. European Space Research and Technology Center, ESTEC, Noordwijk, Netherlands) *In* ESA, European Space Power, Volume 1 Aug. 1989 p 443-450 (For primary document see N90-17678 10-20)
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A 9 kV, 300 W power supply developed for a carcinotron backward wave oscillator used in atmospheric physics research is described. The total ripple and noise is less than 4 millivolts peak to peak, with only 0.5 Joules of stored energy. This can be reduced to 400 microvolts peak to peak when higher stored energy is allowed or by the application of feedback voltage to the lower end of the floating high voltage supply which allows modulation up to more than 100 KHz. ESA

N90-17743# ANT Nachrichtentechnik, Backnang (Germany, F.R.).
INTRINSIC PROPERTIES OF HIGH VOLTAGE WIRES THAT MAY CAUSE SPORADIC DISCHARGES IN SPACE VACUUM **c33**
Klaus H. Geissler *In* ESA, European Space Power, Volume 1 Aug. 1989 p 451-455 (For primary document see N90-17678 10-20)
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The mechanism of high voltage discharges that has caused spurious switchoffs of high power traveling wave tube amplifiers is traced to intrinsic properties of high voltage wires. The mechanism described is of general interest since it is based on sporadic degassing along the strands of the high voltage leads. It is more connected to the geometrical arrangement of the wire than to its constituent materials. The nature of discharges that originate from any high voltage lead in space application is largely dependent on the way it is integrated into the flight equipment. Details of the insulation properties of a type of HV (high voltage) wire that has been employed in TWT (travelling wave tube) amplifiers are reported and integration configurations are discussed. ESA

N90-17744# Dornier System G.m.b.H., Friedrichshafen (Germany, F.R.).
POWER CONDITIONING FOR ACTIVE ARRAY SAR ANTENNAS **c33**
W. Schaeper *In* ESA, European Space Power, Volume 1 Aug. 1989 p 457-461 (For primary document see N90-17678 10-20)
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A trade off between different overall concepts rather than circuit details, in designing active array SAR (synthetic aperture radar) antenna power conditioning and distribution subsystems, is presented. A hierarchically structured system employing ac distribution is shown to be favorable. Active antennas are shown to be failure tolerant to a certain extent. Special attention is paid to particular reliability aspects. Breadboard hardware is presented. A discussion of further improvement of pulse energy storage is included. ESA

N90-17745# Padua Univ. (Italy). Dept. of Electrical Engineering.
ANALYSIS OF THE BEHAVIOUR OF A CURRENT-FED MULTI-STAGE VOLTAGE MULTIPLIER WITH CAPACITIVE OUTPUT **c33**
Paolo Tenti, Leopoldo Rossetto, Luigi Malesani, Ingo Arens, Elena Gaio, Roberto Piovan, Arnaldo Bonati, and Fabio Mazzocco (Fabrica Italiana Apparecchiature Radioelettriche S.p.A., Milan.) *In* ESA, European Space Power, Volume 1 Aug. 1989 p 463-469 (For primary document see N90-17678 10-20)
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The behavior of a five-stage voltage multiplier, fed by a series resonant converter and a step-up transformer, is analyzed. The converter acts as a current source at its output. The results of a theoretical steady state analysis of the multiplier in these conditions are reported. Design criteria of capacitor diode voltage multiplier diodes and capacitors are derived. The dynamic behavior is studied by simulating the voltage multiplier activity. A diode model developed for this purpose is described. ESA

N90-17746# Padua Univ. (Italy). Dept. of Electrical Engineering.
ANALYSIS AND DESIGN OF A HV dc/dc SERIES RESONANT CONVERTER USING A MULTI-STAGE VOLTAGE MULTIPLIER **c33**
Paolo Tenti, Leopoldo Rossetto, Luigi Malesani, Ingo Arens, Elena Gaio, Roberto Piovan, Arnaldo Bonati, and Fabio Mazzocco (Fabrica Italiana Apparecchiature Radioelettriche S.p.A., Milan.) *In* ESA, European Space Power, Volume 1 Aug. 1989 p 471-477 (For primary document see N90-17678 10-20)
Copyright Avail: NTIS HC A19/MF A03

A resonant HV (high-voltage), high power electric power converter for satellite applications is described. Converter structure and control are selected in order to maximize efficiency and power density. A control scheme is described, which allows stability, fast system response, and safe operation even under extreme working conditions. Design criteria of the whole system are given, together with simulation results and an overall performance estimation. System efficiency is shown to be 92 percent while the control accuracy is approximately 0.01 percent. ESA

N90-17747# European Space Agency. European Space Research and Technology Center, ESTEC, Noordwijk (Netherlands).
HIGH POWER MEDIUM VOLTAGE ELECTRONIC LOAD **c33**
M. Martin and H. J. N. Spruijt *In its* European Space Power, Volume 1 Aug. 1989 p 479-484 (For primary document see N90-17678 10-20)
Copyright Avail: NTIS HC A19/MF A03

A Pulse Width Modulation (PWM) type, high power (2Kw) medium voltage (200V) electronic load suitable for operation as a stand alone instrument or as an integral part of a more complex test configuration is described. In stand alone operation, the load power is dissipated in a PWM-controlled resistive load. In integral configuration, the load power is returned to the system power source. The operating principle, basic design requirements, hardware implementation, and major test results are explained. ESA

N90-17748# European Space Agency, Paris (France).
EUROPEAN SPACE POWER, VOLUME 2
Jocelyne Landeau, ed. Aug. 1989 352 p Conference held in Madrid, Spain, 2-6 Oct. 1989; sponsored by ESA, Univ. Politecnica de Madrid, and Inst. Nacional de Tecnica Aeroespacial (ESA-SP-294-Vol-2; ISSN-0379-6566; ETN-90-96195) Copyright Avail: NTIS HC A16/MF A03

Solar cells are discussed both from a performance and a manufacturing stand point. Solar array simulations, design procedures and deployment are discussed. Solar array assembly technology, solar generators, manufacturing considerations, testing procedures and welding techniques are described. Performance optimization for all sorts of solar cell and solar array types are discussed. For individual titles, see N90-17749 through N90-17808.

N90-17749# Centre National de la Recherche Scientifique, Valbonne (France). Lab. de Physique du Solide et Energie Solaire.
Ga0.47In0.53As CELLS FOR GaAs-STACKED PHOTOVOLTAIC TANDEMS **c44**
B. Beaumont, P. Garabedian, G. Nataf, J.-C. Guillaume, and C.

Verie *In* ESA, European Space Power, Volume 2 Aug. 1989 p 489-493 Sponsored by PIRSEM-CNRS; AFME; and Euro GaAs PV Federation (For primary document see N90-17748 10-20)
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The conversion efficiency of Ga0.47 In0.53 As photovoltaic structures is investigated. For short-circuit photocurrent densities over 0.76 A/cm2, the electrical characteristics of the cell are controlled by diffusion currents. Optional losses in the top bandgap cell are discussed. For concentrations of over 40 suns, the GaAs cell efficiency can be increased by 7 percent, taking into account optical losses. ESA

N90-17750# Centre National de la Recherche Scientifique, Valbonne (France). Lab. de Physique du Solide et Energie Solaire.
GaAs CELLS ON Si SUBSTRATES: A NEW CHALLENGE FOR SPACE PHOTOVOLTAIC APPLICATIONS c44
A. Freundlich, M. Leroux, J. C. Grenet, A. Saletes, G. Neu, A. Leycuras, J. Massies, P. Gibart, and C. Verie *In* ESA, European Space Power, Volume 2 Aug. 1989 p 495-499 Sponsored by the French Agency for Energy Measurements and the Commission of the European Communities (For primary document see N90-17748 10-20)
Copyright Avail: NTIS HC A16/MF A03

The factors which influence the efficiency and stability of GaAs on Si solar cells are identified. An intensive study of GaAs/Si structural and electronic materials properties is presented. Growth defects in GaAs/Si, resulting most probably from lattice mismatching, induce minority carrier lifetimes much lower than that routinely obtained for homoepitaxial GaAs. Large impurity cross diffusions from the substrate into the GaAs epilayer and vice versa prevent the formation of np GaAs cells on p-type Si. Experimental measurements and modeling studies of these effects on solar photovoltaic conversion efficiency are discussed. ESA

N90-17751# Centro Informazioni Studi Esperienze, Milan (Italy).
ON-ORBIT DEMONSTRATION OF GaAs SOLAR CELL AND PANEL TECHNOLOGIES c44
C. Flores, F. Paletta, L. Brambilla, A. Caon, R. Contini, R. Gajo, E. Rossi, C. Signorini, and R. L. Crabb *In* ESA, European Space Power, Volume 2 Aug. 1989 p 501-506 Prepared in cooperation with Fabrica Italiana Apparecchiature Rafioelettriche, Milan, Italy and ESTEC, Noordwijk, Netherlands (For primary document see N90-17748 10-20)
Copyright Avail: NTIS HC A16/MF A03

Phase one of the GaAs Solar Array Experiment Adaptation for in-orbit TDP (technological demonstration program) is described. Results of the experiment foresee the launching of a 30 W GaAs flight panel powering a scientific satellite for a two year low earth orbit mission. Nine hundred 4 cm squared and twenty 16 cm squared GaAs solar cells were produced and assembled in demonstration panels. They are submitted to environmental tests in order to evaluate their compliance with a variety of technological processes and typical mission requirements. The results of these tests are described. ESA

N90-17752# Centro Informazioni Studi Esperienze, Milan (Italy).
ADVANCED GaAs SPACE SOLAR CELLS BY MOCVD TECHNIQUE c44
C. Flores, D. Passoni, and G. Timo *In* ESA, European Space Power, Volume 2 Aug. 1989 p 507-510 (For primary document see N90-17748 10-20)
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The growth of multilayer structures using Metal Organic Chemical Vapor Deposition (MOCVD) is described. An MOCVD reactor designed to study and manufacture high efficiency GaAs solar cells for use in space is described. Epitaxial technology seems to be more promising than liquid phase epitaxy which is at present the most popular technique for solar cell production. The advantages of the epitaxial over the liquid phase epitaxy technique are outlined. The conversion efficiency of cells already produced using this technique is 18.4 percent. ESA

N90-17753# Energies Nouvelles et Environnement S.A., Brussels (Belgium).
FABRICATION OF ULTRA THIN GaAs AND Ge SUBSTRATES FOR HIGH EFFICIENCY SOLAR CELLS c44
G. R. Smekens, Ph. Lauwers, P. Maes, and Ph. Lievens *In* ESA, European Space Power, Volume 2 Aug. 1989 p 511-513 (For primary document see N90-17748 10-20)
(Contract ESA-7616/88/N2/1W)
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A multiwire slicing technique allowing GaAs and Ge crystals to be cut with low material consumption, high yield and low surface damage, is described. The operational parameters of the slicing operation are described. The influence of the thickness and surface quality of the wafers is discussed. Subsequent lopping and polishing operations are described. Final wafer quality evaluation is given in terms of thickness, surface roughness and bow. ESA

N90-17754*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
GaAs SOLAR CELLS WITH V-GROOVED EMITTERS c44
S. G. Bailey, N. Fatemi, D. M. Wilt, G. A. Landis, and R. D. Thomas *In* ESA, European Space Power, Volume 2 Aug. 1989 p 515-518 (For primary document see N90-17748 10-20)
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A GaAs solar cell with a V-grooved front surface is described. It shows improved optical coupling and higher short-circuit current compared to planar cells. The GaAs homojunction cells, manufactured by OrganoMetallic Chemical Vapor Deposition (OMCVD), are described. The V-grooves were formed by anisotropic etching. Reflectivity measurements show significantly lower reflectance for the microgrooved cell compared to the planar structure. The short circuit current of the V-grooved solar cell is consistently higher than that of the planar controls. ESA

N90-17755# Escuela Tecnica Superior de Ingenieros Aeronauticos, Madrid (Spain). Inst. de Energia Solar.
AlGaAs/GaAs SOLAR CELLS WITH EFFICIENCIES GREATER THAN 22 PERCENT c44
C. Algora, G. L. Araujo, A. Marti, and L. Mayet (Institut National des Sciences Appliquees de Lyon, Villeurbanne, France) *In* ESA, European Space Power, Volume 2 Aug. 1989 p 519-523 Sponsored in part by Instituto Nacional de Tecnica Aeroespacial (For primary document see N90-17748 10-20)
(Contracts CICyT-MC1/85; Accion-Integrada-162/89)
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Production of simple solar cells is described. An isothermal Liquid Phase Epitaxy (LPE) technique is used. A very thin window layer is grown, a good quality junction is achieved, and power conversion efficiencies of 22.8 percent are obtained. The results of different tests carried out on these solar cells are described. ESA

N90-17756# English Electric Valve Co. Ltd., Chelmsford (England).
GaAs SPACE SOLAR CELLS: PILOT PRODUCTION EXPERIENCE USING A MULTI WAFER INFINITE MELT LIQUID PHASE EPITAXY PROCESS c44
T. A. Cross, J. Burrage, C. Hardingham, and A. Potts *In* ESA, European Space Power, Volume 2 Aug. 1989 p 525-529 Sponsored by the Ministry of Defence, London, England and the Dept. of Trade and Industry, London, England (For primary document see N90-17748 10-20)
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The experience gained and results obtained from a GaAs solar cell production facility are described. Structure and processing steps, with emphasis on the benefits of the multi-wafer, infinite melt, Liquid Phase Epitaxy (LPE) technique are discussed. Efficiencies of over 19 percent are achieved. The performance of cells fabricated with and without an epitaxial buffer layer are discussed. The performance of LPE based GaAs cells is discussed with reference to the more complex single junction and monolithic

multijunction solar cell devices which are now becoming more practicable. ESA

N90-17757# Newcastle-upon-Tyne Univ. (England). Dept. of Physics.
RADIATION EFFECTS IN ITO/InP SOLAR CELLS **c44**
N. M. Pearsall, N. Robson, I. Forbes, R. Hill, and C. Goodbody (Royal Aerospace Establishment, Farnborough, England) *In* ESA, European Space Power, Volume 2 Aug. 1989 p 531-536 Sponsored by the Ministry of Defence, London, England (For primary document see N90-17748 10-20)
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Results of proton exposure and annealing experiments carried out on ITO/InP (Indium-tin-oxide/Indium phosphide) solar cells are discussed. ITO/InP solar cells have potentially significant advantages for space applications due to superior radiation resistance compared to silicon or gallium arsenide based cells. The ITO/InP solar cells are exposed to proton energies ranging from 2 to 9 MeV. The performance changes, including spectral response and reverse saturation current variations, following exposure to isotropic 9 MeV proton irradiation are discussed. The first experimental flight data for ITO/InP solar cells are reported. ESA

N90-17758*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
INDIUM PHOSPHIDE SOLAR CELL RESEARCH IN THE UNITED STATES: COMPARISON WITH NON-PHOTOVOLTAIC SOURCES **c44**
I. Weinberg, C. K. Swartz, and R. E. Hart, Jr. *In* ESA, European Space Power, Volume 2 Aug. 1989 p 537-542 Previously announced as N89-27868 (For primary document see N90-17748 10-20)
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Highlights of the InP solar cell research program are presented. Homojunction cells with efficiencies approaching 19 percent are demonstrated, while 17 percent is achieved for ITO/InP cells. The superior radiation resistance of the two latter cell configurations over both Si and GaAs cells has been shown. InP cells aboard the LIPS3 satellite show no degradation after more than a year in orbit. Computed array specific powers are used to compare the performance of an InP solar cell array to solar dynamic and nuclear systems. ESA

N90-17759# Allgemeine Elektrizitaets-Gesellschaft, Wedel (Germany, F.R.).
APPLICATION OF GALLIUM ARSENIDE SOLAR CELL ARRAYS FOR LONG DURATION LOW EARTH ORBIT MISSIONS LIKE COLUMBUS
F. Reissmann and M. Baumgart (Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Cologne, Germany, F.R.) *In* ESA, European Space Power, Volume 2 Aug. 1989 p 545-548 Sponsored by Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt and BMFT (For primary document see N90-17748 10-20)
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A comparison of low earth orbit area to power and power to mass figures for GaAs, Si and Si-bifacial solar generators is presented. It is shown that the use of GaAs solar cells leads to a significant increase in power to area ratio. This is due to the low temperature sensitivity of the GaAs cells and lower particle degradation characteristics. First module experience with ultrasonic welding of GaAs solar cells shows good results. The development of the module technology, in the context of the German national GaAs module technology development contract, is discussed. ESA

N90-17760# Technische Univ., Berlin (Germany, F.R.). Inst. fuer Raumflug- und Reaktortechnik.
STRUCTURAL AND OPERATIONAL ASPECTS OF THE CONCENTRATING SARA-LOUVER SOLAR GENERATOR **c44**
K. D. Bunte, D. Rex, S. Wuebker, and W.-D. Ebeling (Erno Raumfahrttechnik G.m.b.H. Bremen, Germany, F.R.) *In* ESA, European Space Power, Volume 2 Aug. 1989 p 549-556 (For primary document see N90-17748 10-20)
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A functional description of the Solar Array with RAdiating mirrors (SARA) louver solar generator concept is presented. Used in low earth orbits, this solar generator has reduced air drag. The influence of misalignment towards the sun, manufacturing errors and integration errors are discussed. The way in which the highly nonlinear temperature distribution in the reflector fins leads to thermal-stable fin design is outlined. The deployment and focussing mechanisms of the reflectors are described. ESA

N90-17761# Nippon Electric Co. Ltd., Kanagawa (Japan).
SFU SOLAR ARRAY **c44**
Y. Shibayama, H. Arai, K. Matsui, K. Hama, A. Ushirokawa, M. Natori, K. Takahashi, N. Wakasugi, and T. Anzai (Institute for Unmanned Space Experiments Free Flyer, Tokyo, Japan) *In* ESA, European Space Power, Volume 2 Aug. 1989 p 557-562 Sponsored by the New Energy and Industrial Technology Development Organization (For primary document see N90-17748 10-20)
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The Space Flyer Unit (SFU) equipped with two flexible solar array wings is described. The SFU is a reusable, multi-purpose free flyer to be launched by the Japanese H-2 launch vehicle in early 1994. Unique features of the flexible solar array are described. The solar array wing is made of a single extendible mast with fold-out solar cells. Deployed and stowed configurations of the wing are shown. The results of qualification tests performed on the solar array are presented. ESA

N90-17762# Centre National d'Etudes Spatiales, Toulouse (France).
THE GSR3: A NEW APPROACH FOR SOLAR ARRAY DEPLOYMENTS **c44**
A. Mamode, D. Gangloff, and J. L. Bastard (Aerospatiale, Cannes, France) *In* ESA, European Space Power, Volume 2 Aug. 1989 p 563-567 (For primary document see N90-17748 10-20)
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The GSR3 solar array concept, designed to provide a high performance to cost ratio and good reliability, is presented. Results of qualification tests on two development models are presented. Deployment analysis refinements are described. The GSR3 development plan is presented. Frictionless hinges used in the deployment of the arm are described. ESA

N90-17763# Centre National d'Etudes Spatiales, Toulouse (France).
DEPLOYMENT SIMULATION FOR THE THIRD GENERATION SOLAR ARRAYS GSR3 **c44**
A. Mamode, E. Conde, C. Verne, M. Rouchon, and J. L. Bastard (Aerospatiale, Cannes, France) *In* ESA, European Space Power, Volume 2 Aug. 1989 p 569-572 (For primary document see N90-17748 10-20)
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Deployment analysis of the Amede concept solar array is described. This concept does away with regulation and synchronization devices. This makes high reliability simulation necessary in order to ensure that there be no interference with the satellite, no stop during deployment, and limited latching shocks. The deployment analysis is carried out using dynamics analysis of mechanism software, the validity of which is checked on the deployment of a moke-up on air cushions. The results of the Spacebus solar array deployment in two dimensions, and the moke-up deployment test and simulation are presented. ESA

N90-17764# Fokker B.V., Amsterdam (Netherlands). Solar Array Mechanism Group.
SOLAR ARRAY DESIGNS FOR COLUMBUS ELEMENTS **c44**
Henk J. Cruijssen *In* ESA, European Space Power, Volume 2 Aug. 1989 p 573-584 (For primary document see N90-17748

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Four possible solar array subsystem concepts for the Columbus elements are presented. The solar array sub-system requirements are different between the polar platform and the free flying laboratory. A maximum design commonality is achieved with the flat-pack solar array. This design can be used with small modifications for the Columbus polar platform option A or B and the Columbus free flying laboratory. Details of the solar arrays used in each of these instances are provided. ESA

N90-17765# AEG-Telefunken, Wedel (Germany, F.R.).
A LOW COST ANTICHARGING CONNECTION SYSTEM FOR SOLAR GENERATORS AND ITS APPLICATION ON ASPERA SOLAR ARRAY **c44**
Juergen W. Koch *In* ESA, European Space Power, Volume 2 Aug. 1989 p 587-590 (For primary document see N90-17748 10-20)
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Low cost methods of protecting solar generators from discharge event damage are presented. Solar generators in orbit have shown potential partial or total failure in solar cell performance due to discharge damage. A cheap technique of having all coverglass surfaces connected to each other and to the ground and all solar cells connected to their coverglasses by conductive adhesives is described. This wiring technique, used on the Aspera solar array is described. ESA

N90-17766# AEG-Telefunken, Wedel (Germany, F.R.).
ULTRASONIC AND PARALLEL GAP WELDING OF GaAs SOLAR CELLS, EXPERIMENTAL AND SIMULATION RESULTS **c44**
S. Reul and W. Snakker *In* ESA, European Space Power, Volume 2 Aug. 1989 p 591-596 (For primary document see N90-17748 10-20)
Copyright Avail: NTIS HC A16/MF A03

Different ultrasonic and parallel gap welding techniques are discussed. Their application to the welding of GaAs solar cells is outlined. The results of finite element simulation of thermal, electrical and mechanical parameters affecting parallel gap welding are presented. Thermal cycling test for both types of welding are performed. Welding tests demonstrate problematic breakage behavior for parallel gap, but not for ultrasonic welding. In both cases deep thermal cycling is successful. ESA

N90-17767# Aerospatiale, Cannes (France).
THE ISO SOLAR GENERATOR: SOLAR CELLS AND OSR MIXED **c44**
J. C. Chiarini *In* ESA, European Space Power, Volume 2 Aug. 1989 p 597-600 (For primary document see N90-17748 10-20)
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The solar generator system of the Infrared Space Observatory (ISO) is described. The solar protection system, which increases the whole system reliability, does away with a deployable structure and offers cost and mass-saving advantages, is described. The design of the solar array, made up of aluminum skins and honeycomb core panels linked to the spacecraft via a glass fiber truss, is described. The silicon solar cells mixed with MgF2-coated Optical Solar Reflectors (OSRs) are described. ESA

N90-17768# Allgemeine Elektrizitaets-Gesellschaft, Wedel (Germany, F.R.).
DESIGN DEVELOPMENT AND QUALIFICATION OF A SOLAR ARRAY WITH OSRS (SSM) BONDED TO THE ISO SPACECRAFT RIGID SUNSHIELD **c44**
J. Schmidt-zurBorg and B. Wodke *In* ESA, European Space Power, Volume 2 Aug. 1989 p 601-606 (For primary document see N90-17748 10-20)
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The solar array system of the Infrared Space Observatory (ISO) is described. Solar cells and Optical Solar Reflectors (OSRs) cover the sunshield which protects the cryogenic system of the telescope from direct illumination. The sunshield, separated into two parts creating a 150 degrees dihedral, is described. A 30C seasonal variation in solar array temperature results in a wide variation in power output. Ways in which this fluctuation power output are compensated for are described. Power profile optimization techniques are outlined. ESA

N90-17769# Pilkington Bros. Ltd., Ormskirk (England).
DIRECT GLASSING OF SILICON SOLAR CELLS **c44**
P. A. White, R. L. Crabb, and A. A. Dollery (European Space Agency. European Space Research and Technology Center, ESTEC, Noordwijk, Netherlands) *In* ESA, European Space Power, Volume 2 Aug. 1989 p 607-611 (For primary document see N90-17748 10-20)
Copyright Avail: NTIS HC A16/MF A03

An alternative method of attaching coverglasses to silicon solar cells, currently achieved using silicon adhesives, is presented. The process is a direct bond between the glass and cell and uses an electrostatic technique. An essential preequisite of the process is a coverglass with the same expansion coefficient as the cell. The coverglass and cell are joined by a permanent, chemical, anodic bond which is formed by subjecting the cell and coverglass to voltage, temperature and pressure whilst in intimate contact with each other. Since the front surface of the solar cell is one of the bonding interfaces, it is important to understand the significance of any changes in the bonding process to the cell. The basic theory of direct glassing is reviewed. Recent results of research in this area are presented. ESA

N90-17770# Allgemeine Elektrizitaets-Gesellschaft, Wedel (Germany, F.R.).
A CONCEPT OF A PILOT PRODUCTION PLANT FOR DIRECTLY GLASSED SILICON **c44**
Juergen W. Koch and Gerd Neuhaeusser *In* ESA, European Space Power, Volume 2 Aug. 1989 p 613-615 Sponsored in part by ESA/ESTEC (For primary document see N90-17748 10-20)
Copyright Avail: NTIS HC A16/MF A03

A pilot production line, designed to manufacture solar cells with electrostatically bonded coverglasses, is described. The purpose of the production facility is to evaluate the cost effectiveness of this direct glassing technology. The design of the bonding machine is described and the production targets are identified. The advantages of the electrostatically bonded coverglass solar cells, especially in the field of geostationary mission applications, are discussed. They have the advantage over traditional solar cells of being more lightweight and more resistant to ultraviolet radiation. ESA

N90-17771# European Space Agency. European Space Research and Technology Center, ESTEC, Noordwijk (Netherlands).
DEVELOPMENT OF AN ALUMINIUM SOLAR CELL INTERCONNECTOR TECHNOLOGY **c44**
J. C. Larue and Uwe Hoffmann (Allemeine Elektrizitaets-Gesellshaft, Wedel, Germany, F.R.) *In its* European Space Power, Volume 2 Aug. 1989 p 617-621 (For primary document see N90-17748 10-20)
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A space solar cell interconnection technique based on the ultrasonic welding of aluminum alloy foil interconnectors is described. The technique provides protection against atomic oxygen erosion and significant weight reduction. In the present state of development, it could be considered for assembly of 2 cm by 4 cm cells on solar arrays used on five year low earth orbit missions. Metallurgical improvement work in progress to increase the fatigue lifetime and to adapt it to the assembly of larger solar cells is described. ESA

N90-17772# Mitsubishi Electric Corp., Hyogo (Japan).
ASSEMBLY TECHNOLOGY OF GaAs SOLAR CELL **c44**
H. Matsumoto, S. Yoshida, T. Oda, M. Okubo, and Y. Okawa (Mitsubishi Electric Corp., Kamakura, Japan) *In* ESA, European

Space Power, Volume 2 Aug. 1989 p 623-627 (For primary document see N90-17748 10-20)
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The parallel gap welding technique used on GaAs solar cells is described. To find the lowest thickness of solar cell that can be welded by this technique, welding experiments are carried out on GaAs solar cells with thicknesses ranging between 100 and 280 microns. Results of these tests are presented. Coupon modules of 4 cm by 4 cm and 2 cm by 4 cm solar cells with a thickness of 100 microns are produced. Crack problems with these thin cells are described. ESA

N90-17773# Allgemeine Elektrizitaets-Gesellschaft, Wedel (Germany, F.R.).
MANUFACTURE AND TESTING OF A SOLAR PANEL ASSEMBLY COMPRISING BIFACIAL SOLAR CELLS (AMOC-SPA) **c44**
Uwe Hoffmann and Juergen W. Koch *In* ESA, European Space Power, Volume 2 Aug. 1989 p 629-634 Sponsored by ESA/ESTEC (For primary document see N90-17748 10-20)
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The concept, manufacture and testing of the Solar Panel Assembly (SPA) are described. Bifacial solar cells, flexible harness, striped substrates and blanket integrated cushioning are all features of this solar panel. The SPA is designed to be modular. The power output, for an operating voltage of 7.2 V, was approximately 100 W for 192 5 cm by 5 cm solar cells, each under front and rear side illumination. Results of further tests and of a flight acceptance test are presented. ESA

N90-17774# Allgemeine Elektrizitaets-Gesellschaft, Wedel (Germany, F.R.).
TEMPERATURE MEASUREMENT DURING WELDING OF SOLAR CELLS AND CALIBRATION OF FINITE ELEMENT MODELS **c44**
S. Reul and H. Broeker *In* ESA, European Space Power, Volume 2 Aug. 1989 p 635-640 Sponsored by ESA/ESTEC (For primary document see N90-17748 10-20)
Copyright Avail: NTIS HC A16/MF A03

Infrared sensors used for temperature measurement during welding, measurement of electrical transfer resistance during welding, calibration of three dimensional welding simulation models, and experimental verification, are described. Test results show that temperature measurement is possible and accurate. Measurement of electrical potentials during welding is accurate enough for calculation of transfer resistances by adaption of finite element simulations. Experimental verification is successful for different models and parameters. ESA

N90-17775*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
NASA ADVANCED SPACE PHOTOVOLTAIC TECHNOLOGY: STATUS, POTENTIAL AND FUTURE MISSION APPLICATIONS
Dennis J. Flood, Michael Piszczor, Jr., Paul M. Stella, and Gary L. Bennett *In* ESA, European Space Power, Volume 2 Aug. 1989 p 643-646 Prepared in cooperation with JPL/CALTECH, Pasadena, CA and NASA, Washington (For primary document see N90-17748 10-20)
Copyright Avail: NTIS HC A16/MF A03 CSCL 10B

The long term goals of the NASA program in space photovoltaic research are presented. The long range goals are to develop technology capable of achieving 300 W/kg for planar arrays and 300 W per sq m for concentrator arrays. InP and GaAs planar and concentrator cell research projects are described. The near term program of developing the Advanced Photovoltaic Solar Array (APSA) intended to produce 130 W/kg using thin (62 micron) silicon cells, is described. Ways in which this program will provide a baseline for development of 300 W/kg arrays are described. ESA

N90-17776# Messerschmitt-Boelkow-Blohm G.m.b.H., Ottobrunn (Germany, F.R.).
ASSESSMENT OF SOLAR CELL QUALITY CRITERIA **c44**
G. J. LaRoche *In* ESA, European Space Power, Volume 2 Aug. 1989 p 647-652 (For primary document see N90-17748 10-20)
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A quality standard for solar generators is described. Its purpose is to determine what confidence one can place in the predicted values for electrical performance, physical integrity, and visual appearance of solar generators. Physical integrity and visual appearance are eliminated as criteria in a special experimental study based only on electrical performance criteria. It is found that hardware submitted only to electrical performance testing yields the same electrical performance as hardware made to meet the other standards as well. A revision of applicable criteria in terms of developing more cost effective solar generator manufacturing techniques is discussed. ESA

N90-17777# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Cologne (Germany, F.R.).
HIGH-EFFICIENT SOLAR CELLS FOR SPACE APPLICATION
M. Baumgart and K.-D. Rasch (Telefunken Electronic G.m.b.H., Heilbronn, Germany, F.R.) *In* ESA, European Space Power, Volume 2 Aug. 1989 p 653-657 (For primary document see N90-17748 10-20)
(Contract BMFT-01-RS-8706-ZK/PA-2)
Copyright Avail: NTIS HC A16/MF A03

The results of GaAs cell and silicon cell research, carried out by the German national fundamental research and development program on solar cells, are described. Metal Organic Vapor Phase Epitaxy (MOVPE) techniques, producing up to 17.5 percent efficiency for AlGaAs/GaAs cells at a temperature of 25C are described. The High ETA silicon cells show efficiencies of up to 15.6 percent, 8 percent higher than that for standard silicon cells. Both cell types are compared with respect to efficiency, radiation damage and mass. ESA

N90-17778# Solarex Corp., Rockville, MD. Aerospace Div.
REDUCTION OF 50 MICRON THICK SOLAR CELL WEIGHT BY SELECTIVE BACK CONTACT SILVER PLATING **c44**
Joseph B. Creager and Edward M. Gaddy *In* ESA, European Space Power, Volume 2 Aug. 1989 p 659-662 (For primary document see N90-17748 10-20)
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Alternatives to the thick silver back contact on solar cells are discussed. The amount of silver presently used is not necessary for the cell's electrical performance. It lowers the cell power to weight ratio and causes the cell to bow. An almost all-aluminum contact is described. The minimum amount of contact metal, whether silver or aluminum, required to meet the functional requirements of the cell, is calculated. A two stage plating process, which reduces the thickness of silver in a selected area of the cell's back contact is described. ESA

N90-17779# Escuela Tecnica Superior de Ingenieros de Telecomunicacion, Barcelona (Spain).
ASSESSMENT OF BIFACIAL SILICON SOLAR CELLS FOR SPACE APPLICATIONS
R. Alcubilla, L. Prat, E. Blasco, E. Garcia, X. Correig, J. Calderer, L. Castaner, J. M. Ruiz, M. Cid, and E. Gomez (Escuela Tecnica Superior de Ingenieros Aeronauticos, Madrid, Spain) et al *In* ESA, European Space Power, Volume 2 Aug. 1989 p 663-667 (For primary document see N90-17748 10-20)
Copyright Avail: NTIS HC A16/MF A03

Research on bifacial solar cell behavior before and after irradiation is described. Experimental results of proton and electron irradiation are presented. The irradiation doses range from 10(13) to 10(15) sq cm for electrons and 10(9) to 10(13) sq cm for isotropical protons (10 MeV, 5 MeV, 500 keV). The potential use of bifacial cells in space missions is analyzed from a device point of view. ESA

N90-17780# Telefunken Electronic G.m.b.H., Heilbronn (Germany, F.R.).
PILOT PRODUCTION OF 70 MICRON THIN SILICON SOLAR CELLS **c44**
K.-D. Rasch, R. Schilling, K.-H. Tentscher, and K. Bogus (European Space Agency. European Space Research and Technology Center, ESTEC, Noordwijk, Netherlands) *In* ESA, European Space Power, Volume 2 Aug. 1989 p 669-673 (For primary document see N90-17748 10-20)
(Contract ESTEC-7299/87/NL/IW(SC))
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A pilotline program for 70 micron solar cells is described. The proces and handling techniques are outlined. The mechanical and electrical yields of more than 500 2 cm by 4 cm and 4 cm by 6 cm solar cells already produced are analyzed. The results of various environmental tests are presented. The results show good power to weight ratios compared to that of thicker standard cells. ESA

N90-17781# Centre National de la Recherche Scientifique, Villeurbanne (France). Lab. de Physique du Solide et Energie Solaire.
GaAs BACK POINT CONTACT SOLAR CELL SIMULATION **c44**
B. Fofana (Universite Nationale de Cote d'Ivoire, Abidjan.), B. Beaumont, B. Bensaid, F. Raymond, J. C. Guillaume, and C. Verie *In* ESA, European Space Power, Volume 2 Aug. 1989 p 677-683 (For primary document see N90-17748 10-20)
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The feasibility of applying the high efficiency Si back surface point contact structure to GaAs solar cell for space applications is investigated. The optimum geometric parameters are determined by studying mechanical parameters such as bandgap, photoabsorption coefficient, intrinsic carrier concentration, carrier mobility and carrier lifetime. The estimated efficiencies are shown to be highly sensitive to the cell thickness, the front surface recombination velocity, the contact diameter and the contact spacing. It is anticipated that realistically optimized GaAs back surface point contact photovoltaic cells may achieve high conversion efficiencies under concentrated solar spectra. For space applications, efficiencies as high as 20 percent and 23 percent, depending on solar illumination, are expected. Sensitivity to operating temperature and concentrated sunlight of both Si and GaAs back surface point contact cells is discussed. ESA

N90-17782# Messerschmitt-Boelkow-Blohm G.m.b.H., Ottobrunn (Germany, F.R.).
THE INMARSAT-2 SOLAR GENERATOR PANELS **c44**
L. Preuss *In* ESA, European Space Power, Volume 2 Aug. 1989 p 685-688 (For primary document see N90-17748 10-20)
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The two identical solar generator wings of the geosynchronous INMARSAT 2 satellite are described. Each wing consists of three rigid panels and a yoke which serves as the connecting link to the satellite solar array drive assembly. The electrical design of the solar generator panels is described. The techniques used in the verification and determination of total power, based on measurements of subsection level, are presented. ESA

N90-17783# Messerschmitt-Boelkow-Blohm G.m.b.H., Ottobrunn (Germany, F.R.).
A PULSED SOLAR SIMULATOR FOR ELECTRICAL PERFORMANCE TESTS OF SPACE SOLAR CELLS/ARRAYS **c44**
W. Lukschal and A. P. Robben (European Space Agency. European Space Research and Technology Center, ESTEC, Noordwijk, Netherlands) *In* ESA, European Space Power, Volume 2 Aug. 1989 p 689-693 (For primary document see N90-17748 10-20)
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A pulsed xenon solar simulator, designed to cope with future measurement problems with advanced solar cells and solar cell arrays, is described. The simulator, consisting of a flash lamp, a power supply, and an operator console, is capable of illuminating one side of a flat target 3.5 m by 3.5 m placed in a vertical position 17 m from the light source. Uniformity of illumination is within a range of 4 percent when measured with a test solar cell against a reference standard in a fixed position on the same plane. The maximum power that can be measured is 2 W. ESA

N90-17784# Universidad Politecnica de Madrid (Spain). Inst. de Energia Solar.
LIMITS OF EFFICIENCY OF SOLAR CELLS UNDER AMO-SPECTRUM ILLUMINATION: COMPARISON BETWEEN Si AND GaAs CELLS **c44**
G. L. Araujo and A. Marti *In* ESA, European Space Power, Volume 2 Aug. 1989 p 695-700 Sponsored by the Spanish Comision Interministerial de Ciencia y Tecnologia (For primary document see N90-17748 10-20)
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Research on the efficiency limits of GaAs and Si solar cells is described. Radiative and Auger recombination losses are taken into consideration in the calculations. An assessment of the benefits to be expected from applying techniques to concentrate the sunlight and restrict the angle of acceptance of the cells is made. It is concluded that a limiting efficiency of about 36.3 percent for GaAs and of 32.8 percent for Si cells can be obtained under high concentration illumination or by highly restricting the acceptance angle. ESA

N90-17785# Pilkington P.E. Ltd., Bodelwyddan (Wales).
SOLAR CELL COVERGLASSES WITH ENHANCED THERMAL AND MECHANICAL PROPERTIES **c44**
A. M. Head *In* ESA, European Space Power, Volume 2 Aug. 1989 p 701-706 Sponsored in part by RAE and INTELSAT (For primary document see N90-17748 10-20)
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The use of optical coatings to optimize the thermal properties of coverglass is described. A chemical process that makes them stronger and easier to handle is outlined. Solar absorptance is reduced to half its original value. Infrared emittance is increased by more than 0.04. The strength of the coverglass is raised by a factor of 12. Automated strength checking equipment to ensure that coverglasses can withstand the cell glassing process is proposed. ESA

N90-17786# Fokker Space and Systems, Amsterdam (Netherlands).
STRUCTURAL DESIGN OF THE TELECOM 2 SOLAR ARRAY **c44**
L. C. M. vanLent *In* ESA, European Space Power, Volume 2 Aug. 1989 p 707-713 (For primary document see N90-17748 10-20)
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The solar array adapted to the specific requirements of the Telecom 2 satellite is described. Special attention is paid to complex electrical design and power analysis. The lightweight structure providing a high power to mass ratio is described. The mechanical environment tests are described. Mathematical models are checked against the results of vibration tests. ESA

N90-17787# Aerospatiale, Cannes (France).
THE ITALSAT SOLAR ARRAY **c44**
G. Giacometti, G. A. Martin, W. Schultze, and K. Ribbe (Messerschmitt-Boelkow-Blohm G.m.b.H., Ottobrunn, Germany, F.R.) *In* ESA, European Space Power, Volume 2 Aug. 1989 p 715-719 (For primary document see N90-17748 10-20)
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The structural, mechanical, and electrical performance of the ITALSAT solar array are described. The two wings of the solar generator are described. The high power to weight ratio of these wings makes them well suited for use on communication satellites. The satellite is designed for a five year lifetime. Simplification in the hold-down and release systems for the solar arrays compared to previous, closely related, satellite wings, are outlined. ESA

N90-17788# Sharp Corp., Nara (Japan).
CIC TYPE THIN DIODE FOR SOLAR ARRAY **c44**
K. Kamimura, Y. Tonomura, H. Yoshioka, Y. Uchida, Y. Kiyota, T. Matsutani, A. Suzuki, S. Ikegami, H. Arai, and K. Murata (Nippon Electric Co. Ltd., Kanagawa, Japan) et al *In* ESA, European Space Power, Volume 2 Aug. 1989 p 721-726 (For primary document see N90-17748 10-20)
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A thin diode, which has a similar shape to Connector Integrated solar Cells (CIC) is described. The diode consists of a 100 micron thick n type silicon diode chip, a gold plated silver interconnector, and a 1000 micron thick optical solar reflector. The diode has good electrical characteristics. It has low forward voltage, low reverse current, and high breakdown voltage. Results of evaluation tests of its reliability for space applications are presented. ESA

N90-17789# Aix-Marseilles Univ. (France). Lab. de Photoelectricite.
INVESTIGATIONS ON HOT SPOTS EFFECTS IN REVERSE BIASED SPATIAL SOLAR CELLS **c44**
J. P. David, J. Duveau, J. Guerin, A. Naamane, S. Noureddine, A. Michel, E. Rapp, and M. Roussel (Centre National d'Etudes Spatiales, Toulouse, France) *In* ESA, European Space Power, Volume 2 Aug. 1989 p 727-733 (For primary document see N90-17748 10-20)
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Silicon solar cells were tested in order to measure their coupled thermal and electrical behavior. Tests were carried out when the cells were reverse biased and the negative voltage was increased. The results of these tests are presented and used to get better insight into the breakdown mechanisms, leakage phenomena, and hot spot effects which can affect the reliability of solar generators in certain operating conditions. Cell shadowing or breakage, and cell characteristics evolution involving mismatching are some of the operating conditions investigated. The thermal behavior of biased spatial solar cells is tested for temperatures between 30 C and 150 C. ESA

N90-17790# MATRA Espace, Toulouse (France).
NEW MODELS AND TECHNIQUES FOR PREDICTING RADIATION EFFECTS ON SOLAR ARRAY PERFORMANCES **c44**
J. P. Estienne and J. G. Ferrante *In* ESA, European Space Power, Volume 2 Aug. 1989 p 735-740 (For primary document see N90-17748 10-20)
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An analytical technique for predicting solar array degradation is presented. The model is more general and accurate than those presently used in space industry and relies on the calculation of transmitted flux at solar cell conjunctions. Any solar cell configuration can be accounted for by the Matcharge software which incorporates techniques used in nuclear radiation shielding projects. ESA

N90-17791# Aerospatiale, Cannes (France).
SOLAR CELL ELECTRODYNAMIC CHARACTERISTICS TEST EQUIPMENT **c44**
M. Coustal and Ph. Samson *In* ESA, European Space Power, Volume 2 Aug. 1989 p 741-744 (For primary document see N90-17748 10-20)
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The transient mode, when a spacecraft switches from one power supply to another, is analyzed. The analysis is based on electrodynamic data concerning the solar cells which are connected to the electrical section in a consistent network. An electrodynamic performance evaluation system, to be used in measuring the performance of photovoltaic components, is described. The measuring method selected for this system, and the different development steps involved in the systems development are described. ESA

N90-17792# British Aerospace Public Ltd. Co., Stevenage (England). Space Systems Div.
THE ELECTRICAL DESIGN OF SOLAR ARRAYS FOR COMMUNICATION SATELLITES
R. Kimber *In* ESA, European Space Power, Volume 2 Aug. 1989 p 745-749 (For primary document see N90-17748 10-20)
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The major factors that have an impact on the design of a solar array are described. Constraints on the choice of a particular solar cell type, once the maximum spacecraft requirements at the end of life have been defined, are outlined. The algorithms used to develop a computer program to assist in array sizing are discussed. The interface of the array with the spacecraft and the future design of arrays are considered. ESA

N90-17793# Allgemeine Elektrizitaets-Gesellschaft, Wedel (Germany, F.R.).
ASSESSMENT OF IN-ORBIT PERFORMANCE DATA OF A BIFACIAL FLIGHT EXPERIMENT
H. Bebermeier *In* ESA, European Space Power, Volume 2 Aug. 1989 p 753-758 Sponsored by Deutsch Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt and BMFT (For primary document see N90-17748 10-20)
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An assessment of flight data from two different bifacial solar array modules is presented. The modules were launched on the LIPS3 mission in 1987. The electrical performance of the arrays was measured over a period of one year. Recommendations for future improvements in the design of bifacial arrays are presented. It is concluded that bifacial solar array technology is still an attractive solution for improving the photoelectric conversion efficiency of silicon solar arrays in low earth orbit. ESA

N90-17794*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
ON-ORBIT RESULTS OF THE LIPS 3/InP HOMOJUNCTION SOLAR CELL EXPERIMENT
David J. Brinker *In* ESA, European Space Power, Volume 2 Aug. 1989 p 759-764 Previously announced as N89-26292 (For primary document see N90-17748 10-20)
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The flight performance of the NASA indium phosphide homojunction cell module on the LIPS 3 satellite is presented. The experimental objectivewas to measure the InP cell performance in the natural radiation environment in a circular 1100 km altitude orbit inclined 60 degrees. Flight data for the first year is close to expected values. No degradation in the short-circuit current is seen. Details of cell structure and flight module design are discussed. ESA

N90-17795# Aerospatiale, Cannes (France).
SPOT 1 SOLAR ARRAY: THREE YEARS IN ORBIT PERFORMANCE EVALUATION
P. Samson, E. Rapp, and D. Poeck (Allgemeine Elektrizitaets-Gesellschaft, Wedel, Germany, F.R.) *In* ESA, European Space Power, Volume 2 Aug. 1989 p 765-769 (For primary document see N90-17748 10-20)
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The solar array of the SPOT 1 satellite is described. Designed for a 1 kW power output, it has been in orbital operation for three years. The main electrical design aspects of the array are presented. In-flight data results are described and compared with preflight predictions. It is concluded that in-orbit performance degradation is significantly lower than predicted. Radiation impact was lower than expected and loss factors were overestimated. ESA

N90-17796# Allgemeine Elektrizitaets-Gesellschaft, Wedel (Germany, F.R.).
DESIGN DEVELOPMENT, QUALIFICATION, AND FLIGHT PRODUCTION OF AN ATOX RESISTANT FLEXIBLE SOLAR ARRAY FOR LOW EARTH ORBIT MISSION

D. Poeck *In* ESA, European Space Power, Volume 2 Aug. 1989 p 771-774 (For primary document see N90-17748 10-20)
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The space telescope solar array is described. It features a double rollout array made up of two wings. Each of the wings contains two blankets. The ability of the array components to withstand the Atomic Oxygen (ATOX) environment and survive 30,000 thermal cycle fluctuations between -100 C to 100 C is discussed. The qualification procedures for the components are described. ESA

N90-17797*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
THE ADVANCED PHOTOVOLTAIC SOLAR ARRAY PROGRAM
R. M. Kurland (TRW Space Technology Labs., Redondo Beach, CA.) and Paul M. Stella *In* ESA, European Space Power, Volume 2 Aug. 1989 p 775-781 (For primary document see N90-17748 10-20)
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The background and development status of an ultralightweight flexible-blanket flatpack, fold-out solar array is presented. It is scheduled for prototype demonstration in late 1989. The Advanced Photovoltaic Solar Array (APSA) design represents a critical intermediate milestone of the goal of 300 W/kg at beginning-of-life (BOL) with specific performance characteristics of 130 W/kg (BOL) and 100 W/kg at end-of-life (EOL) for a 10-year geosynchronous geostationary earth orbit 10-kW (BOL) space power system. The APSA wing design is scalable over a power range of 2 to 15 kW and is suitable for a full range of missions including Low Earth Orbit (LEO), orbital transfer from LEO to geostationary earth orbit and interplanetary flight. ESA

N90-17798# Tokyo Univ. (Japan).
THE SOLAR ARRAY OF JAPANESE SOLAR OBSERVATORY SATELLITE SOLAR-A
A. Ushirokawa, J. Onoda, M. Kohbata, Y. Shibayama, H. Irikado, and J. Takahashi (Nippon Electric Co. Aerospace Systems Corp., Japan) *In* ESA, European Space Power, Volume 2 Aug. 1989 p 783-788 (For primary document see N90-17748 10-20)
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The solar array of the Solar-A solar observatory, to be launched in the Summer of 1991, is described. The solar array consists of two rigid deployable three-axis solar panels. The structure, mechanical design and analysis tests, that were involved in the development of these solar arrays, are described. Results of deployment tests, release tests, static load tests, and vibration tests are presented. ESA

N90-17799# Centre National d'Etudes Spatiales, Toulouse (France).
THE SOLAR ARRAY DESIGN OF THE VESTA SMALL BODIES SPACECRAFT
D. J. P. Moura and E. Rapp *In* ESA, European Space Power, Volume 2 Aug. 1989 p 789-794 (For primary document see N90-17748 10-20)
Copyright Avail: NTIS HC A16/MF A03

The solar array which is to equip the Vesta mission is described. Tests carried out to ensure that the solar array will be able to withstand the severe conditions to which it will be exposed during its deep space mission are described. Ninety-six solar cells from the array are submitted to the proton radiation, solar flux, and low temperatures of deep space conditions. Mechanical analysis of the honeycomb reinforcements of the carbon fiber skins is described. Thermal analysis of an aerodynamic deflector located on the upper edge of the panels to decrease the temperature of the solar arrays, is outlined. ESA

N90-17800# Solarex Corp., Rockville, MD. Aerospace Div.
LIGHTWEIGHT, LOW COST, THIN SILICON CELL ARRAYS **c44**
R. Dominguez and L. Slifer *In* ESA, European Space Power, Volume 2 Aug. 1989 p 795-800 (For primary document see N90-17748 10-20)
Copyright Avail: NTIS HC A16/MF A03

A thin silicon solar array module using novel components and materials, developed for geosynchronous orbit applications, is described. Evaluation tests of components, materials and assemblies are described. A power density of 120.1 w per sq m are obtained for the final design, with a specific power of 146.7 w/kg. Cost estimates for arrays of 1 kW and 5 kW and of life power, after 10 years in geosynchronous orbit, show a reduction of 20 percent compared to the cost of a conventional array. ESA

N90-17801# Tokyo Univ. (Japan). Inst. of Space and Astronautical Science.
OUTLINE OF HIGH VOLTAGE SOLAR ARRAY EXPERIMENT USING SFU PLATFORM
H. Kuninaka, K. Takahashi, M. Natori, A. Ushirokawa, K. Kuriki, K. Murata, K. Matui, H. Arai, and S. Ikegami (Nippon Electric Co. Ltd., Yokohama, Japan) *In* ESA, European Space Power, Volume 2 Aug. 1989 p 803-808 (For primary document see N90-17748 10-20)
Copyright Avail: NTIS HC A16/MF A03

Series connection between solar cells on a Space Flyer Unit (SFU) is used to generate high voltage power by a series parallel connection technique. Interference due to space plasma is shown to be severe for such a high voltage solar array. Ionospheric plasma interactions are studied numerically and experimentally based on a similarity law so as to find the plasma-induced force and the level of material degradation. A second two dimensional high voltage solar array experiment designed to determine the upper limit of the operational voltage in low earth orbit, is outlined. ESA

N90-17802# Physikalisch-Technische Studien G.m.b.H., Freiburg (Germany, F.R.).
SOLAR ARRAYS IN THE LEO-PLASMA ENVIRONMENT: A MODEL FOR LEAKAGE CURRENT PHENOMENA DEDUCED FROM EXPERIMENTAL AND THEORETICAL STUDIES **c44**
H. Thiemann, Robert W. Schunk, and L. Gerlach (European Space Agency. European Space Research and Technology Center, ESTEC, Noordwijk, Netherlands) *In* ESA, European Space Power, Volume 2 Aug. 1989 p 809-813 (For primary document see N90-17748 10-20)
Copyright Avail: NTIS HC A16/MF A03

The interactions between high voltage solar arrays and Low Earth Orbit (LEO) plasma are described. It is shown that one of the main effects of plasma/solar array interactions is leakage current which can significantly reduce the power capacity of the solar arrays. Leakage current can lead to discharges and arcing, leading to material degradation and electrical power deficiencies. The leakage current effect is studied. A preliminary interaction model is developed. The model shows a large current surge during the voltage turn-on. ESA

N90-17803# Centre d'Etudes et de Recherches, Toulouse (France). Dept. d'Etudes et de Recherches Technologie Spatiale.
REVIEW OF SYNERGISTIC ENVIRONMENTAL INTERACTIONS: GUIDELINES FOR NEW TESTING APPROACHES ON FUTURE SOLAR ARRAYS **c44**
J. Berry, L. Levy, A. Paillous, K. Bogus, L. Gerlach, L. Pelenc, and N. Pchalek (Allgemeine Elektrizitaets-Gesellschaft, Wedel, Germany, F.R.) *In* ESA, European Space Power, Volume 2 Aug. 1989 p 815-821 (For primary document see N90-17748 10-20)
(Contract ESTEC-7438/87)
Copyright Avail: NTIS HC A16/MF A03

The difficulties involved in accurately reproducing space environment conditions in simulation tests are discussed. Most existing test facilities test the effect of a single space environment component. The need for multifactor environment simulation facilities in order to effectively understand solar array failures that have occurred in orbit is stressed. Since no such multifactor test

facilities are available, a review is presented of already available one component effect information. An extrapolation of this data towards a synergistic effects analysis is outlined. ESA

N90-17804# National Space Development Agency, Tokyo (Japan).
IN-ORBIT PERFORMANCE OF CS-3a SPACECRAFT GaAs SOLAR ARRAY
N. Takata, M. Tokunaga, M. Goto, M. Okubo, I. Osawa, M. Omura, S. Yoshida, and S. Hokuyo (Mitsubishi Electric Corp., Hyogo, Japan) *In* ESA, European Space Power, Volume 2 Aug. 1989 p 823-828 (For primary document see N90-17748 10-20)
Copyright Avail: NTIS HC A16/MF A03

The solar array of the CS-3A (communications satellite-3a) is described. It covers the outer cylindrical surface of the spin-stabilized communications satellite. The satellite was launched in Feb. 1988. The mission life is seven years. Initial flight performance of the solar array after launch is described. It is concluded that the solar array has survived the launch environment with little or no damage. It has been generating the expected amount of power and is predicted to be able to last for the seven years of the mission. ESA

N90-17805# European Space Agency. European Space Research and Technology Center, ESTEC, Noordwijk (Netherlands).
MICROMETEOROID IMPACTS ON SILVER BUS BAR TARGETS AT ELEVATED VOLTAGES
K. Bogus, A. P. Robben, F. R. Krueger, D. Maas, M. Rott, W. Reschauer, E. Schneider, K. Weber, and H. Thiemann (Physikalisch-Technische Studien G.m.b.H., Freiburg, Germany, F.R.) *In* ESA, European Space Power, Volume 2 Aug. 1989 p 829-836 (For primary document see N90-17748 10-20)
Copyright Avail: NTIS HC A16/MF A03

Micrometeoroid impact on silver bus bars at elevated positive voltages is studied for different micrometeoroid particle sizes. For particles of less than 100 microns, the possibility of short circuit generation increases with the applied voltage. Spectacular arc discharges and burning do not occur however. These are triggered by 350 micron particles. A clear correlation between short circuits and arc discharges is not identified. The role of the impact plasma in the process of short circuit generation is discussed. ESA

N90-17806# Ingenieurbuero Krueger, Darmstadt (Germany, F.R.).
SIMULATION OF MICROMETEOROID IMPACTS BY LASER PULSES **c18**
F. R. Krueger, D. Maas, K. Rohr, M. Rott, and K. Bogus (European Space Agency. European Space Research and Technology Center, ESTEC, Noordwijk, Netherlands) *In* ESA, European Space Power, Volume 2 Aug. 1989 p 837-842 (For primary document see N90-17748 10-20)
Copyright Avail: NTIS HC A16/MF A03

The use of a laser and a dust accelerator in simulating the effect of micrometeoroid impact on solar arrays is described. It is concluded that although true simulation with a laser is impossible, it is a cheap and reproducible means of studying some aspects of micrometeoroid interaction with solar arrays in order to develop protection equipment against electric failures caused by micrometeoroids. Using the method, either comparable impact plasmas, or comparable impact craters can be produced but not both at once. ESA

N90-17807# Universidad Politecnica de Madrid (Spain). Instituto de Energia Solar.
IMPROVED SOLAR CELLS TESTING FIXTURES **c09**
G. Sala, J. Aguilera, J. C. Zamorano, E. Sanchez, A. M. Grass, and T. J. Gomez (Instituto Nacional de Tecnica Aeroespacial, Esteban Terradas, Torrejon de Ardoz, Spain) *In* ESA, European Space Power, Volume 2 Aug. 1989 p 843-849 (For primary document see N90-17748 10-20)
Copyright Avail: NTIS HC A16/MF A03

A rotating platform which can lock, connect and test the electrical parameters of two cells, locating them in the same position under the light beam, is described. Multi-filter spectral response equipment which operates in combination with the platform is outlined. Tests carried out in comparison with a reference cell are described. The main stages in the testing process are discussed. The purpose of the experimentaion is to determine the correct criteria to be used in solar cell systems design. ESA

N90-17808# Artegie (France).
WPK: SOLAR ARRAY DIMENSIONING TOOL **c44**
Ph. Bobo *In* ESA, European Space Power, Volume 2 Aug. 1989 p 851-854 (For primary document see N90-17748 10-20)
Copyright Avail: NTIS HC A16/MF A03

The main features of the solar array dimensioning tool WPK (Watts per kilo) are presented. The WPK is described from a user point of view. Common functions such as power output computation or sensitivity curve drawings are reviewed with examples of standard output. It is concluded that the accuracy of the WPK is rather poor. It is however a useful tool for preliminary studies and provides good results for middle class hypotheses (especially temperature and light intensity). Its performance drops with extreme conditions. ESA

N90-17809*# Martin Marietta Aerospace, Denver, CO. Astronautics Group.
BOOSTER PROPULSION/VEHICLE IMPACT STUDY, 2 Final Report, 15 Jul. 1987 - 8 Feb. 1988
P. Johnson, S. Satterthwaite, C. Carson, and J. Schnackel 8 Feb. 1988 218 p
(Contract NAS8-36945)
(NASA-CR-179313; NAS 1.26:179313; MCR-88-1000) Avail: NTIS HC A10/MF A02 CSCL 21H

This is the final report in a study examining the impact of launch vehicles for various boost propulsion design options. These options included: differing boost phase engines using different combinations of fuels and coolants to include RP-1, methane, propane (subcooled and normal boiling point), and hydrogen; variable and high mixture ratio hydrogen engines; translating nozzles on boost phase engines; and cross feeding propellants from the booster to second stage. Vehicles examined included a fully reusable two stage cargo vehicle and a single stage to orbit vehicle. The use of subcooled propane as a fuel generated vehicles with the lowest total vehicle dry mass. Engines with hydrogen cooling generated only slight mass reductions from the reference, all-hydrogen vehicle. Cross feeding propellants generated the most significant mass reductions from the reference two stage vehicle. The use of high mixture ratio or variable mixture ratio hydrogen engines in the boost phase of flight resulted in vehicles with total dry mass 20 percent greater than the reference hydrogen vehicle. Translating nozzles for boost phase engines generated a heavier vehicle. Also examined were the design impacts on the vehicle and ground support subsystems when subcooled propane is used as a fuel. The most significant cost difference between facilities to handle normal boiling point versus subcooled propane is 5 million dollars. Vehicle cost differences were negligible. A significant technical challenge exists for properly conditioning the vehicle propellant on the ground and in flight when subcooled propane is used as fuel. Author

23 CHEMISTRY AND MATERIALS (GENERAL)

N90-17810*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
INITIATION PRECURSORS AND INITIATORS IN LASER-INDUCED COPOLYMERIZATION OF STYRENE AND MALEIC ANHYDRIDE IN ACETONE
Gilda A. Miner, Willard E. Meador, and C. Ken Chang (Christopher Newport Coll., Newport News, VA.) Washington Mar. 1990

11 p
(NASA-TM-4166; L-16703; NAS 1.15:4166) Avail: NTIS HC A03/MF A01 CSCL 07A

The initiation step of photopolymerized styrene/maleic anhydride copolymer was investigated at 365 nm. UV absorption measurements provide decisive evidence that the styrene/maleic anhydride charge transfer complex is the sole absorbing species; however, key laser experiments suggest intermediate reactions lead to a monoradical initiating species. A mechanism for the photoinitiation step of the copolymer is proposed. Author

N90-17811*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
THE APPLICATION OF A COMPUTER DATA ACQUISITION SYSTEM FOR A NEW HIGH TEMPERATURE TRIBOMETER
Charles D. Bonham (Sverdrup Technology, Inc., Cleveland, OH.) and Christopher DellaCorte 1990 38 p Proposed for presentation at the Annual Meeting for the Society of Tribologists and Lubrication Engineers, Denver, CO, 7-11 May 1990
(NASA-TM-102508; E-5310; NAS 1.15:102508) Avail: NTIS HC A03/MF A01 CSCL 07A

The two data acquisition computer programs are described which were developed for a high temperature friction and wear test apparatus, a tribometer. The raw data produced by the tribometer and the methods used to sample that data are explained. In addition, the instrumentation and computer hardware and software are presented. Also shown is how computer data acquisition was applied to increase convenience and productivity on a high temperature tribometer. Author

24 COMPOSITE MATERIALS

Includes physical, chemical, and mechanical properties of laminates and other composite materials.
For ceramic materials see *27 Nonmetallic Materials.*

N90-17812 California Univ., Berkeley.
MECHANICAL ASPECTS OF INTERFACES IN HIGH PERFORMANCE COMPOSITES Ph.D. Thesis
Hengchu Cao 1988 129 p
Avail: Univ. Microfilms Order No. DA8916605

A study is made of important mechanical aspects of interfaces existing in advanced materials, such as ceramic matrix composites, thin film devices, ceramic coatings on substrates and metal/ceramic joints. The ultimate objective is to rationalize the mechanical properties of a variety of high performance materials containing interfaces. Firstly, residual stresses are ubiquitous in systems that contain materials having different thermal and mechanical properties. Secondly, failure from interfaces inherently involves mixed mode fracture and exhibits distinct characteristics. Therefore, a comprehensive understanding of the mechanical behavior of heterogeneous systems requires complete knowledge regarding residual stresses and interfacial fracture characteristics. These two key issues are extensively explored. The residual stresses and cracking in metal/ceramic bonded systems is investigated. Interfacial debonding and the characterization of interface fracture resistance is also studied. Dissert. Abstr.

N90-17813*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
THREE-DIMENSIONAL STRESS ANALYSIS OF PLAIN WEAVE COMPOSITES
John D. Whitcomb Nov. 1989 33 p
(NASA-TM-101672; NAS 1.15:101672) Avail: NTIS HC A03/MF A01 CSCL 11D

Techniques were developed and described for performing three-dimensional finite element analysis of plain weave composites. Emphasized here are aspects of the analysis which are different from analysis of traditional laminated composites, such as the mesh generation and representative unit cells. The analysis was used to study several different variations of plain weaves which illustrate the effects of tow waviness on composite moduli, Poisson's ratios, and internal strain distributions. In-plane moduli decreased almost linearly with increasing tow waviness. The tow waviness was shown to cause large normal and shear strain concentrations in composites subjected to uniaxial load. These strain concentrations may lead to earlier damage initiation than occurs in traditional cross-ply laminates. Author

N90-17814 California Univ., San Diego.
HIGH-ORDER MIXTURE HOMOGENIZATION OF PERIODIC NONLINEAR COMPOSITES Ph.D. Thesis
Alberto Toledano 1989 84 p
Avail: Univ. Microfilms Order No. DA8925096

An asymptotic mixture theory of composites with periodic microstructure is presented for rate independent inelastic responses, such as elastoplastic deformation. Key elements are the modeling capability of simulating critical interaction across material interfaces and the inclusion of the kinetic energy of microdisplacement. The construction of the proposed mixture model, which is deterministic, instead of phenomenological, is accomplished by resorting to a variational approach. The principle of virtual work is used for total quantities to derive mixture equations of motion and boundary conditions, while Reissner's mixed variational principle (1984, 1986), applied to the incremental boundary value problem yields consistent mixture constitutive relations. The general theory is applied to bi-laminated and fiber reinforced composites. In order to assess the model accuracy, numerical experiments were conducted for static and dynamic loads. The prediction of the model in the time domain was obtained by an explicit finite element code. DYNA2D is used to furnish numerically exact data for the problems by discretizing the details of the microstructure. On the other hand, the model capability of predicting effective tangent moduli was tested by comparing results with NIKE2D. In all cases, good agreement was observed between the predicted and exact data for plastic, as well as, elastic responses. Dissert. Abstr.

N90-17815*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
OBSERVATIONS OF FATIGUE CRACK INITIATION AND DAMAGE GROWTH IN NOTCHED TITANIUM MATRIX COMPOSITES
R. A. Naik (Analytical Services and Materials, Inc., Hampton, VA.) and W. S. Johnson Jan. 1990 36 p Presented at the 3rd Symposium on Composite Materials: Fatigue and Fracture, Lake Buena Vista, FL, 6-7 Nov. 1989
(NASA-TM-101688; NAS 1.15:101688) Avail: NTIS HC A03/MF A01 CSCL 11D

The purpose was to characterize damage initiation and growth in notched titanium matrix composites at room temperature. Double edge notched or center open hole SCS-6/Ti-15-3 specimens containing 0 deg plies or containing both 0 and 90 deg plies were fatigued. The specimens were tested in the as-fabricated (ASF) and in heat-treated conditions. A local strain criterion using unnotched specimen fatigue data was successful in predicting fatigue damage initiation. The initiation stress level was accurately predicted for both a double edge notched unidirectional specimen and a cross-plied center hole specimen. The fatigue produced long multiple cracks growing from the notches. These fatigue cracks were only in the matrix material and did not break the fibers in their path. The combination of matrix cracking and fiber/matrix debonding appears to greatly reduce the stress concentration around the notches. The laminates that were heat treated showed a different crack growth pattern. In the ASF specimens, matrix cracks had a more tortuous path and showed considerable more crack branching. For the same specimen geometry and cyclic stress, the (0/90/0) laminate with a hole had far superior fatigue resistance than the matrix only specimen with a hole. Author

N90-17816# David Taylor Research Center, Bethesda, MD. Dept. of Ship Materials Engineering.
DAMPING LOSS FACTOR DETERMINATION OF GLASS AND GRAPHITE FIBER COMPOSITES Research Development Technical Evaluation Report, Jan. - Jul. 1989

Roger M. Crane and John W. Gillespie, Jr. (Delaware Univ., Newark.) 1 Sep. 1989 41 p
(AD-A214535; DTRC/SME-89-59) Avail: NTIS HC A03/MF A01 CSCL 11/4

Material damping of laminated composites is experimentally determined using a cantilever beam test with an impulse excitation. Data acquisition and manipulation is carried out using both an IBM PC-AT and a GenRad 2500 Series FFT Analyzer. Unidirectional continuous fiber 0 and 90 degree laminates were fabricated from glass/epoxy (Hercules S2-Glass/3501-6), graphite/epoxy (Hercules AS4/3501-6) and graphite/polyetheretherketone (ICI AS4/PEEK (APC-2) to investigate the effect of fiber and matrix properties as a function of frequency, up to 1000 Hz, on the damping of composites. The S2-glass/3501-6 composite had a higher loss factor than the AS4/3501-6 exhibiting a linear increase with increasing frequency and the loss factor for the S2-glass varying nonlinearly with frequency. The 90 degree material exhibited a higher damping loss factor than the 0 degree, varying nonlinearly with increasing frequency. In the 90 degree orientation, the glass fiber composite had loss factors that was approximately a factor of 2 greater than the 0 degree orientation. The 0 degree AS4/PEEK had a loss factor that was approximately equal to that of the 0 degree AS4/3501-6. The 90 degree AS4/PEEK had a loss factor that was approximately 50 percent less than the AS4/3501-6 and 25 percent greater than the S2-glass/3501-6. GRA

N90-17817*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
PREDICTION OF HIGH TEMPERATURE METAL MATRIX COMPOSITE PLY PROPERTIES
J. J. Caruso and C. C. Chamis 1988 19 p Presented at the 29th Structures, Structural Dynamics, and Materials Conference, Williamsburg, VA, 18-20 Apr. 1988; cosponsored by AIAA, ASME, AHS, and ASC
(NASA-TM-102490; E-5280; NAS 1.15:102490) Avail: NTIS HC A03/MF A01 CSCL 11D

The application of the finite element method (superelement technique) in conjunction with basic concepts from mechanics of materials theory is demonstrated to predict the thermomechanical behavior of high temperature metal matrix composites (HTMMC). The simulated behavior is used as a basis to establish characteristic properties of a unidirectional composite idealized an as equivalent homogeneous material. The ply properties predicted include: thermal properties (thermal conductivities and thermal expansion coefficients) and mechanical properties (moduli and Poisson's ratio). These properties are compared with those predicted by a simplified, analytical composite micromechanics model. The predictive capabilities of the finite element method and the simplified model are illustrated through the simulation of the thermomechanical behavior of a P100-graphite/copper unidirectional composite at room temperature and near matrix melting temperature. The advantage of the finite element analysis approach is its ability to more precisely represent the composite local geometry and hence capture the subtle effects that are dependent on this. The closed form micromechanics model does a good job at representing the average behavior of the constituents to predict composite behavior. Author

N90-17818# Akron Univ., OH. Polymer Engineering Center.
INTERNAL FAILURES IN MODEL ELASTOMERIC COMPOSITES
A. N. Gent and Y. C. Hwang Nov. 1989 37 p
(Contract N00014-85-K-0222)
(AD-A215923) Avail: NTIS HC A03/MF A01 CSCL 11/4

Finite element methods have been used to calculate the rate of release of strain energy caused by growth of an internal crack in some model elastic composites under tension. A layer of a linearly-elastic material was considered, bonded between two flat or two spherical rigid surfaces. The reduction in strain energy caused by a small circular crack at the interface was found to be only about one-half of that due to a similar crack in the center of the layer, in accord with the conjecture of Andrews and King. Cracks in the center of a thin layer bonded between flat surfaces caused about the same release of energy as a crack in the center of a thick specimen under the same tensile stress. On the other hand, a crack in a thin layer bonded between two spherical surfaces caused a much larger rate of energy release, depending on the radius of the layer relative to its minimum thickness. Growth of an initial crack would thus occur at a small applied stress. For thin layers between both flat and spherical surfaces, the rate of release of energy decreased as the crack grew, indicating that the crack would stabilize at a finite size. These conclusions are in accord with some observations of cracks in thin elastic layers. GRA

N90-17819# Texas A&M Univ., College Station. Mechanics and Materials Center.
STUDIES ON DEFORMATION AND FRACTURE OF VISCOELASTIC COMPOSITE MATERIALS Final Report, 15 Jun. 1987 - 14 Sep. 1989
R. A. Schapery Nov. 1989 35 p
(Grant AF-AFOSR-0257-87; AF Proj. 2302)
(AD-A216095; MM-5762-89-14; AFOSR-89-1696TR) Avail: NTIS HC A03/MF A01 CSCL 11/4

Theoretical and experimental work on the deformation and fracture of structural composite materials, is summarized. Research on limited path-independence of work for inelastic laminates under axial and torsional loading and unloading is summarized first. These studies on pure axial loading, pure torsional loading, and combined axial-torsional loading provide support for the theoretically predicted path-independence of work for limited deformation paths. This path-independence is shown to be helpful in the development of simplified methods of deformation and fracture characterization and analysis. Summarized next is research on delamination of multidirectional laminates. It is concerned with: (1) delamination testing, (2) moment-curvature testing to obtain the J integral, (3) extensions of the J integral analysis, (4) fractography and delamination in the SEM, and (5) analysis of width effects and crack front curvature effects in the double cantilever specimen. GRA

N90-17820# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
INVESTIGATION OF FAILURE MODES IN A CERAMIC COMPOSITE UNDER OFF-AXIS LOADING M.S. Thesis
Walter E. Fink, III Dec. 1989 119 p
(AD-A216133; AFIT/GAE/ENY/89D-9) Avail: NTIS HC A06/MF A01 CSCL 11/4

The purpose of this study was to investigate the failure behavior of a ceramic composite (Corning's Nicalon/CAS II) under off-axis loading, and compare the test results with material behavior modeling techniques for polymeric composites. Six different orientations (0, 15, 30, 45, 60, and 90 degrees off axis), with three specimens at each orientation, were tested in an MTS machine. The 60 and 90 degree specimens were tested by gluing them into a fixture that had already been installed into the grips. All others were installed in the grips. Thereafter, other specimens were tested incrementally, stopping along the way, to find when and where matrix cracking starts. Acoustic emission was used to determine when cracking starts and replication was used to confirm the cracking. The 0, and 15 degree specimens started cracking in the matrix during the linear portion of the stress-strain curve, at about 35 percent of their ultimate strengths. The rest of the orientations cracked when they reached the ultimate strength. All off-axis load orientations broke parallel to the direction of the fiber, except the 15 degree which was 25 degrees off-axis. The 0 degree specimen showed a decrease in transverse strain before final failure occurred. GRA

N90-17821# California Univ., Santa Barbara.
THE PROCESSING AND MECHANICAL PROPERTIES OF HIGH TEMPERATURE/HIGH PERFORMANCE COMPOSITES. BOOK 1, SECTION 1: COATINGS AND INTERFACES Annual Report No. 3, 15 Sep. 1988 - 14 Sep. 1989
A. G. Evans and R. Mehrabian 15 Oct. 1989 399 p
(Contract N00014-86-K-0753)
(AD-A216141) Avail: NTIS HC A17/MF A03 CSCL 11/4

The third annual report of the University Research Initiative project at UCSB on High-Temperature, High-Performance Composites consists of four sections compiled in a total of six books. The first section is concerned with coatings and interfaces and is expressed in Book 1. The second section focuses on strength and fracture resistance and is found in Books 2 and 3. The third section describes research on flow and creep strength, this information is presented in Book 4. The fourth section is concerned with various aspects of processing in matrices and composites and is described in Books 5 and 6. GRA

N90-17822# California Univ., Santa Barbara. Dept. of Materials.
THE PROCESSING AND MECHANICAL PROPERTIES OF HIGH TEMPERATURE/HIGH PERFORMANCE COMPOSITES. BOOK 4, SECTION 3: FLOW AND CREEP STRENGTH Annual Report No. 3, 15 Sep. 1988 - 14 Sep. 1989
A. G. Evans and R. Mehrabian 15 Oct. 1989 194 p
(Contract N00014-86-K-0753)
(AD-A216144) Avail: NTIS HC A09/MF A01 CSCL 11/4

Substantial activity has been initiated to examine creep strength and ductility during both plastic flow and creep in the presence of reinforcements. The variables of principal interest are the reinforcement aspect ratio and size, as well as their fracture/debond resistance. Papers include: Flow strength and ductility of an aluminum alloy reinforced with SiC particulates; Aspects of the high temperature performance of ceramics and ceramic composites; Brittle-to-ductile transition in silicon carbide; Mechanical properties of particulate-reinforced aluminum-matrix composites; Combined Mode I - Mode III fracture toughness of alumina particulate-reinforced aluminum alloy-matrix composites; Numerical study of high temperature creep deformation in metal-matrix composites; Plastic flow in ductile materials containing a cubic array of rigid spheres; Influence of pressure on damage evolution and fracture in metal-matrix composites; and Fracture mechanism maps in stress space. GRA

N90-17823# California Univ., Santa Barbara.
THE PROCESSING AND MECHANICAL PROPERTIES OF HIGH TEMPERATURE/HIGH PERFORMANCE COMPOSITES. BOOK 5, SECTION 4: PROCESSING: MATRICES AND COMPOSITES, PART 1 Annual Report No. 3, 15 Sep. 1988 - 14 Sep. 1989
A. G. Evans and R. Mehrabian 15 Oct. 1989 274 p
(Contract N00014-86-K-0753)
(AD-A216145) Avail: NTIS HC A12/MF A02 CSCL 11/4

The third annual report of the University Research Initiative project at UCSB on High-Temperature, High-Performance Composites consists of sections compiled in a total of six books. The first section in Book 1 is concerned with the properties and structure of bimaterial interfaces and the related problem of coating decohesion and cracking. The second section describes research on the strengths and fracture resistance of brittle matrix composites manufactured with fibers, whiskers and ductile phases. This information is presented in Books 2 and 3. The third section addresses the flow and creep strength of reinforced systems, with emphasis on effects of aspect ratio and the incidence of damage, and is offered in Book 4. The fourth section, Books 5 and 6, describes work on processing of intermetallic and ceramic matrices and composites, as well as numerical modelling of the melt-spinning process. GRA

N90-17824# California Univ., Santa Barbara.
THE PROCESSING AND MECHANICAL PROPERTIES OF HIGH TEMPERATURE/HIGH PERFORMANCE COMPOSITES. BOOK 6, SECTION 4: PROCESSING: MATRICES AND COMPOSITES, PART 2 Annual Report No. 3, 15 Sep. 1988 - 14 Sep. 1989
A. G. Evans and R. Mehrabian 15 Oct. 1989 249 p
(Contract N00014-86-K-0753)
(AD-A216146) Avail: NTIS HC A11/MF A02 CSCL 11/4

The third annual report of the University Research Initiative project at UCSB on High-Temperature, High-Performance Composites consists of sections compiled in a total of six books. The first section in Book 1 is concerned with the properties and structure of bimaterial interfaces and the related problem of coating decohesion and cracking. The second section describes research on the strengths and fracture resistance of brittle matrix composites manufactured with fibers, whiskers and ductile phases. This information is presented in Books 2 and 3. The third section addresses the flow and creep strength of reinforced systems, with emphasis on effects of aspect ratio and the incidence of damage, and is offered in Book 4. The fourth section, Books 5 and 6, describes work on processing of intermetallic and ceramic matrices and composites, as well as numerical modelling of the melt-spinning process. GRA

N90-17825# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
INVESTIGATION OF THE FAILURE MODES IN A METAL MATRIX COMPOSITE UNDER THERMAL CYCLING M.S. Thesis
Paul G. Ermer Dec. 1989 135 p
(AD-A216195; AFIT/GAE/ENY/89D-07) Avail: NTIS HC A07/MF A01 CSCL 11/4

There is currently wide interest in producing a vehicle capable of hypersonic flight. Structural materials in such a vehicle must be able to withstand high temperatures and retain high stiffness. Metal matrix composites (MMCs) are rapidly becoming the strongest candidates for these applications and concurrently, the need to study the effects of thermal cycling on them. This study emphasizes the development of a computer-controlled testing system that thermally fatigues a specimen under a variety of thermal conditions. A titanium matrix composite with silicon carbide fibers (SCS6/Ti-15-3) is the object of this study. To demonstrate the capability of this system, ten thermal fatigue tests were completed. The MMC was cycled from 300 F to 800 F while collecting strain and temperature data. A systematic study was undertaken to investigate the initiation and progression of the damage and its effect on mechanical properties as a function of applied thermal stresses. Results show that for up to 16,750 cycles, material properties remain unchanged and do not correlate with thermal cycling. Interior damage begins at 500 cycles as deformation of the fiber/matrix interface. Exterior damage begins at 1,500 cycles as delamination cracks along the ply seams. GRA

N90-17826# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
THE EFFECT OF LOADING ON THE LASER ABLATION OF GRAPHITE/EPOXY COMPOSITE MATERIAL M.S. Thesis
Joseph L. Hamrick, II Dec. 1989 119 p
(AD-A216209; AFIT/GAE/ENY/89D-12) Avail: NTIS HC A06/MF A01 CSCL 11/4

An investigation was conducted to quantify the effect structural loading of a graphite/epoxy member has upon the mass removal rate during laser ablation. An effective heat of ablation (Q*eff=energy absorbed/mass removed) was used as a measure of this efficiency. A simple physical model of the important factors affecting graphite/epoxy was developed, and predictions were made of the effect of loading on Q*eff. A 3-D finite difference heat transfer code was written to predict the temperature distribution in the composite while modeling the orthotropic nature of the thermal conductivity tensor. The effect of thermal and mechanical loads upon the stress distribution in a single fiber was calculated. A hypothesis was formed that fracture of individual fibers, a process linearly dependent upon applied stress, will remove a fraction of the composite independent of the absorption of laser energy. GRA

N90-17827# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
A STUDY OF FAILURE CHARACTERISTICS IN THERMOPLASTIC COMPOSITE LAMINATES DUE TO AN ECCENTRIC CIRCULAR DISCONTINUITY M.S. Thesis
John A. Daniels Dec. 1989 195 p
(AD-A216226; AFIT/GAE/ENY/89D-06) Avail: NTIS HC A09/MF A01 CSCL 11/4

The purpose of this thesis was to determine (both

experimentally and analytically) the initiation and progression of failure, stress-strain response, and the failure loads of Graphite/Polyetheretherketone (Gr/PEEK) laminates, incorporating an eccentric 0.4 inch circular discontinuity, loaded in axial tension at room temperature. For each ply lay-up, three values of eccentricity were considered (the three values of eccentricity were determined by the hole location within each specimen). In addition, experimentation was conducted to study the effects of boundary conditions on the failure characteristics of the Gr/PEEK laminates; this was accomplished through the use of a special mounting fixture which allowed in-plane rotation of the specimens. Finally, experimentation was conducted, using photoelasticity, to verify the gross stress states of the Gr/PEEK laminates predicted by the analytical study. Analytically, a nonlinear material finite element program was used to predict the initiation and progression of failure, stress-strain response, and the failure loads of the Gr/Peek laminates. In addition, the effects of boundary conditions on the failure modes of the Gr/Peek laminates was studied analytically. And finally, the gross stress states of the Gr/PEEK laminates were considered in the analytical portion of this thesis. GRA

N90-17828# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

EFFECTS OF ELEVATED TEMPERATURES AND THERMAL CYCLING ON CERAMIC COMPOSITE MATERIALS M.S. Thesis

Michael A. Hoobler Dec. 1989 200 p
(AD-A216242; AFIT/GAE/ENY/89D-14) Avail: NTIS HC A09/MF A01 CSCL 11/4

The need to determine the effects of elevated temperature and thermal cycling on the mode 2 fracture toughness of fiber reinforced ceramic composites was identified. The two materials chosen for this purpose in this thesis were CGW 1723 and CGW 7740. In addition to mode 2 fracture toughness, preliminary mode 1 fracture toughness values were determined in order to evaluate similarities or dissimilarities in fracture toughness trends with increasing temperature. A pre-cracking fixture was designed and built to allow for precise pre-cracking of the specimens. A test stand for subjecting specimens to thermal cycling was designed and constructed. CGW 1723 mode 2 specimens were tested at room temperature, 600 F, 1000 F, after being cycled from 130 F to 600 F for 25 cycles, and after exposure to 600 F for 125 minutes. CGW 7740 mode 2 specimens were tested at room temperature. Compliance data was plotted as a function of non-dimensional crack length. 2nd and 3rd order polynomial curves were fitted to the data. These curve fits were compared to a theoretical compliance to crack length relationship. Critical loads were determined from the load-displacement curves by identifying the load at which the specimens compliance changed. GRA

N90-17829# Naval Academy, Annapolis, MD. Dept. of Weapons and Systems Engineering.

THE BEHAVIOR OF A COMPOSITE MATERIAL IN COMPRESSION Final Report, 1988 - 1989

Matthew L. Welborn 14 Jul. 1989 44 p
(AD-A216324; USNA-TSPR-163) Avail: NTIS HC A03/MF A01 CSCL 11/4

In the study of unidirectional composite materials, the fiber-matrix support mechanism is well understood for the case of a tensile load. Under a purely compressive load, however, the behavior of the fibers in the composite is much less well understood. At present, a widely discussed model of the behavior of the composite is that, under an axial compressive load, the fibers will deform slightly into the shape of a sine wave of very small amplitude. This model has been termed microbuckling. The objective of the project was to observe and to quantify this phenomenon of microbuckling in a graphite-epoxy composite. It was found that in properly prepared specimens the microbuckling and its associated wavelength were directly observable. From measurements made of the strains in the composite specimen using both surface-mounted resistive strain guages and electrical resistance of the graphite fibers, the amplitude of the observed microbuckling was calculated. As a significant consequence of the this determination of the amplitude and wavelength of the microbuckling, it was learned that the fibers in a composite structure under a compressive load are actually subject to two types of strain. The first is the compressive strain that is read by the usual, resistive strain guage and the other, a strain at the spatial frequency of the microbuckling, is alternately tension and compression. GRA

N90-17830# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

IMPACT DAMAGE TOLERANCE OF COMPOSITE CYLINDRICAL PANELS M.S. Thesis

Eugene A. Senn Dec. 1989 136 p
(AD-A216401; AFIT/GAE/ENY/89D-34) Avail: NTIS HC A07/MF A01 CSCL 11/4

This thesis studied the impact damage tolerance of composite cylindrical panels subjected to low velocity impacts. Graphite/Epoxy and Kevlar/Polyester panels were investigated. A simple method was devised to model the material as an orthotropic laminate. A nonlinear collapse analysis was performed to predict the strength of the undamaged panels. The sensitivity of the composite panel to small imperfections accounts for the difference between analytical and experimental loads. Imposing a transverse sinusoidal imperfection with a maximum amplitude equal to the thickness of one ply resulted in analytical loads that agreed with experimental loads to within 16 percent at worst. Graphite/Epoxy and Kevlar/Polyester curved panels were impacted with energies of 1 to 3 ft-lbs (velocities of 3.40 to 5.36 ft/sec). No damage occurred for impact energies below 1 to 3 ft-lbs, depending on the ply lay-up. The residual strength of the damaged panel was only 2 to 6 percent lower than the strength of undamaged panels. Ultrasonic C-Scan and microphotographs were taken of panels impacted with energies between 8 to 17 ft-lbs (velocities of 9.62 to 13.89 ft/sec) to investigate and characterize impact damage from the material response point of view. Even at low impact energies, C-scans and stereo x rays show that internal damage occurs even though no exterior signs of damage are visible. The damage can be characterized by matrix cracking, delamination, and fiber breakage. GRA

N90-17831# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

ECCENTRICITY EFFECTS OF SQUARE CUTOUTS ON THE NATURAL FREQUENCIES AND MODE SHAPES OF CURVED RECTANGULAR COMPOSITE PANELS M.S. Thesis

Vincent J. Levraea, Jr. Dec. 1989 222 p
(AD-A216410; AFIT/GAE/ENY/89D-20) Avail: NTIS HC A10/MF A01 CSCL 11/4

The purpose of this study was to investigate the eccentricity of square cutouts on the natural frequencies and mode shapes of circular, cylindrical composite panels. A video holographic interferometry technique was used to determine the first five natural frequencies and mode shapes of the panels. Analytically, predictions for this same data were obtained using the STAGSC-1 finite element program. The primary objective was to examine how cutout eccentricity altered the dynamic characteristics of the panel. A secondary objective was to continue the verification of the dynamic analysis capabilities of the STAGSC-1 program. The panels examined were constructed of Graphite/Epoxy (Gr/Ep) and had an arc length, height, and radius of curvature of 12 inches, 11 inches, and 12 inches, respectively. A 0/-45/+45/90s ply layup was used, which resulted in a panel thickness of 0.04 inches. A clamped-free-clamped-free boundary condition was selected for this study. Cutouts eccentrically located in both the circumferential and tangential directions were considered. Experimentally, 2 inch and 4 inch square cutouts were studied, while the analytical analysis included 2 inch, 3 inch, 4 inch, and 5 inch square cutouts. Only the frequencies are presented for the panels with 3 inch and 5 inch cutouts. It was observed that, in general, eccentrically located cutouts caused small frequency variations when compared to centered cutouts. GRA

N90-17832# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
DAMAGE MECHANISMS AND INDENTER SIZE EFFECTS IN CROSS PLIED CARBON-CARBON COMPOSITES M.S. Thesis
Andrew Kenny Dec. 1989 152 p
(AD-A216413; AFIT/GAE/ENY/89D-18) Avail: NTIS HC A08/MF A01 CSCL 11/4

The microscopic damage mechanisms which cause failure in 2-D carbon-carbon composite beams tested in three point bend were studied, and the effect of the beam thickness and cross plies in the laminate were examined. Local failure modes caused by loading were catagorized. A linear two-dimensional finite element method was used to model beams of two thicknesses. Failure contours computed with Dendis the Tsai-Wu post processor were in good agreement with the experimentally determined microscopic shear crack initiation sites and load levels in the matrix. The loading indenter's diameter and rigidity were found to be effective in controlling certain types of localized cracking. GRA

N90-17833# Naval Ship Research and Development Center, Bethesda, MD. Ship Materials Engineering Dept.
DAMPING LOSS FACTOR DETERMINATION OF GLASS AND GRAPHITE EPOXY LAMINATED COMPOSITES USING VERTICALLY ORIENTED CANTILEVER BEAMS Report, for Jun. - Sep. 1989
Roger M. Crane Nov. 1989 57 p
(AD-A216529; DTRC/SME-89-62) Avail: NTIS HC A04/MF A01 CSCL 11/4

Material damping of laminated composites is experimentally determined using a cantilever beam test with an impulse excitation. The beam is oriented vertically as opposed to the traditional horizontal orientation. Data acquisition and manipulation is carried out using an IBM PC-AT with a high speed, A/D board and analysis software. Unidirectional continuous fiber 0, 90 and + or - 45 degree laminates were fabricated from glass/epoxy (Hercules S2-Glass/3501-6) and graphite/epoxy (Hercules AS4/3501-6) to investigate the effect of fiber and matrix properties as a function of frequency, up to 1000 Hz, on the damping of composites. The vertical orientation provided loss factor results that were significantly different than the tests conducted on the horizontally oriented beams. The results using the vertical orientation are assumed to be more representative of the material loss factor since both accelerations and stresses are more uniform. The glass fiber composite had a higher loss factor than the graphite composites. The loss factor for the 0 degree AS4/3501-6 increased linearly as a function of frequency, whereas the 0 degree S2-Glass/3501-6 had a significant nonlinear increase in loss factor above 700 Hz. GRA

N90-17834*# Quantum Composites, Inc., Midland, MI.
LOW COST TOOLING MATERIAL AND PROCESS FOR GRAPHITE AND KEVLAR COMPOSITES Final Report
William I. Childs Jun. 1987 42 p
(Contract NAS2-12016)
(NASA-CR-179427; NAS 1.26:179427; H-1407) Avail: NTIS HC A03/MF A01 CSCL 11D

An Extruded Sheet Tooling Compound (ESTC) was developed for use in quickly building low cost molds for fabricating composites. The ESTC is a very highly mineral-filled resin system formed into a 6 mm thick sheet. The sheet is laid on the pattern, vacuum (bag) is applied to remove air from the pattern surface, and the assembly is heat cured. The formed ESTC is then backed and/or framed and ready for use. The cured ESTC exhibits low coefficient of thermal expansion and maintains strength at temperatures of 180 to 200 C. Tools were made and used successfully for: Compression molding of high strength epoxy sheet molding compound, stamping of aluminum, resin transfer molding of polyester, and liquid resin molding of polyester. Several variations of ESTC can be made for specific requirements. Higher thermal conductivity can be achieved by using an aluminum particle filler. Room temperature gel is possible to allow use of foam patterns. Author

25 INORGANIC AND PHYSICAL CHEMISTRY

Includes chemical analysis, e.g., chromatography; combustion theory; electrochemistry; and photochemistry.

For related information see also *77 Thermodynamics and Statistical Physics.*.

N90-17835# Central Research Inst. of Electric Power Industry, Tokyo (Japan).
FULL SCALE CATALYTIC COMBUSTION OF METHANE UNDER ATMOSPHERIC PRESSURE
Hisashi Fukuzawa and Shigehiro Mandai Aug. 1988 36 p In JAPANESE; ENGLISH summary
(DE89-772354; CRIE-T-88003) Avail: NTIS (US Sales Only) HC A03/MF A01

Recently, research and development of catalytic combustion has been conducted for NOx control in LNG combined cycle power plant. The design and manufacture of a full scale catalytic combustor for 1300 C, 100 MW gas turbine is described along with the performance in methane combustion test under atmospheric pressure and the availability of the catalytic combustor. The designed and manufactured catalytic combustor consists of a reverse annular preburner, a annular premixer and palladium catalyst. The dimensions of the combustor is 450 diameter by 800 mm. The combustor showed excellent performance in the test, and it is considered that the combustor is able to be applied to gas turbine systems. The excellent performance is expected at the operating conditions of gas turbine as follows; combustion efficiency of 99.8 percent and above, and NOx emission of about 10 ppm. DOE

N90-17836# Aerospace Corp., El Segundo, CA. Chemistry and Physics Lab.
PHOTOELECTRON SPECTROSCOPIC STUDY OF THE INTERACTION OF THIN Fe FILMS WITH THE MoS2(0001) SURFACE
Jeffrey R. Lince, Thomas B. Steward, Malina M. Hills, and Paul D. Fleischauer 1 Nov. 1989 34 p
(Contracts F04701-88-C-0089; DE-AC02-76CH-00016)
(AD-A214348; TR-0089(4945-03)-2; SSD-TR-89-80) Avail: NTIS HC A03/MF A01 CSCL 07/4

The Iron/Molybdenum Disulfide interface was studied by high resolution photoelectron spectroscopy using synchrotron radiation. The evolution of the MO 3d, Fe 3p, and S 2p core levels and of the valence band spectra (hv = 152 eV) during growth of vapor deposited Fe films (1 to 10) indicates the production of sulfur vacancy defects in the MoS2 (0001) surface. Several submonolayer sulfur surface species were formed, including sulfur adsorbed on the Fe surfaces and a reacted Fe-S species. The MoS2 surface was found to be covered for Fe film thicknesses of approx. 10A. Annealing a 10 film to 600 K resulted in the Fe film beginning to agglomerate, while annealing to 700 to 900 K resulted in further agglomeration of the Fe film. Annealing to 700 to 900 K also resulted in reformation of a partially disordered MoS2 (0001)-1 x 1 surface with approx. 5 percent defects, as determined from photoelectron spectroscopy and low-energy electron diffraction. The overlayer film remained primarily in the form of metallic Fe, before and after annealing to temperatures less than or = 900 K, which was shown by the behavior of the Fe3p core level spectra and valence band spectra. Annealing the sample to 1200 K resulted in decomposition of the MoS2 (0001) surface. The results indicate that the Fe/MoS2 (0001) system exhibits some interfacial reactivity but does not form bulk Fe-S compounds. The results were compared to those of previous studies of the Fe/MoS2(0001) system. GRA

N90-17837# Army Armament Research and Development Command, Watervliet, NY.
DETERMINATION OF TRIVALENT CHROMIUM IONS IN CHROMIUM PLATING SOLUTIONS BY ULTRAVIOLET-VISIBLE SPECTROPHOTOMETRY Final Report

Samuel Sopok Nov. 1989 17 p
(AD-A215688; ARCCB-TR-89030) Avail: NTIS HC A03/MF A01 CSCL 07/4

The chemical literature lacks a specific and direct analytical method for adequately monitoring trivalent chromium ions (Cr(III)) in chromium plating solutions during the plating process. In this report, a specific and direct method is presented providing acceptable analysis and monitoring of the trivalent chromium in this process. The optimum operating range of the trivalent chromium is 7.5 g/l maximum in the chromium plating solutions. The resulting precisions are in the range of 0.5 to 1.0 g/l, providing adequate monitoring of these solutions supported by four years of testing. GRA

N90-17838# Massachusetts Univ., Amherst. Dept. of Chemical Engineering.
SURFACE ANALYSES AND MODELLING OF RATE MULTIPLICITY AND INSTABILITIES Annual Progress Report, 1 Jan. - 31 Dec. 1989
Michael P. Harold and W. Curtis Conner 1989 16 p
(Contract DE-FG02-87ER-13772)
(DE90-005418; DOE/ER-13772/2) Avail: NTIS HC A03/MF A01

A large class of noble metal catalyzed reactions exhibit multiple rate phenomena and oscillatory behavior. Most previous observations of these phenomena were at high (atmospheric) pressure and under conditions with severe external mass transport limitations and nonisothermalities. Because of the difficulty in interpreting the data, controversy still exists about whether the multiplicity and oscillations can occur under truly kinetic controlled, isothermal conditions. The occurrence of rate multiplicity and oscillations implies the existence of nonlinear interactions in the sequence of steps comprising the reaction and transport phenomena. The challenges in the study of rate multiplicity and oscillations in catalytic reactions lie in carrying out experiments in which nonisothermalities and mass transport limitations are minimized, and in developing a kinetic model discrimination methodology for reactions which exhibit multiple rate phenomena. This research confronts these questions with two different studies: The first study couples nonlinear mathematical tools with careful kinetics experiments involving the oxidations of carbon monoxide and formaldehyde on an electrically heated platinum wire. The second study involves the development of a novel scanning Fourier transform infrared emission spectroscopic technique to study kinetic instabilities exhibited by reactions carried on supported (wafer) or unsupported catalysts. DOE

N90-17839# Auburn Univ., AL. Dept. of Chemical Engineering.
IMPROVED PERFORMANCE IN CO-PROCESSING THROUGH FUNDAMENTAL AND MECHANISTIC STUDIES IN HYDROGEN TRANSFER AND CATALYSIS Quarterly Report
Christine W. Curtis and James A. Guin 1989 46 p
(Contract DE-AC22-88PC-88801)
(DE90-004794; DOE/PC-88801/T4) Avail: NTIS HC A03/MF A01

To gain a fundamental understanding of the role and importance of hydrogen transfer reactions in thermal and catalytic coprocessing by examining possible hydrogen donation from cycloalkane/aromatic systems and by understanding the chemistry and enhanced reactivity of hydrotreated residuum, as well as by enriching petroleum solvent with potent new donors, nonaromatic hydroaromatics, thereby promoting hydrogen transfer reactions in coprocessing. Progress and a literature review are presented. DOE

N90-17840# Sandia National Labs., Albuquerque, NM.
TERNARY RECIPROCAL SYSTEM OF LITHIUM AND POTASSIUM FLUORIDES AND BROMIDES
N. N. Volker and L. A. Dubinskaya Mar. 1989 5 p Transl. into ENGLISH from Izvestiya Fiziko-Khimicheskogo Nauchno-Issledovatelskogo Instituta pri Irkutskom Gosudarstvennom Universitete, (USSR), v. 2, no. 1, 1953 p 45-47
(Contract DE-AC04-76DP-00789)
(DE90-004938; ALS/TR-89-07) Avail: NTIS HC A01/MF A01

In previous publications, it was noted that ternary reciprocal fluoride-bromide interchange systems have large heat effects. For example, the heat of the exchange reaction LiBr + KF = LiF + KBr is 21.86 kcal/equiv, and the equilibrium is displaced toward the stable pair LiF-KBr. The system is therefore highly singular. The isotherms of lithium fluoride are bent at acute angles on the stable diagonal. DOE

N90-17841# Los Alamos National Lab., NM.
A GAS CHROMATOGRAPH/MASS SPECTROMETRY METHOD FOR DETERMINING ISOTOPIC DISTRIBUTIONS IN ORGANIC COMPOUNDS USED IN THE CHEMICAL APPROACH TO STABLE ISOTOPE SEPARATION
A. M. Martinez, W. D. Spall, and B. F. Smith Jan. 1990 22 p
(Contract W-7405-eng-36)
(DE90-005738; LA-11730-MS) Avail: NTIS HC A03/MF A01

A variety of gas chromatograph/mass spectrometry (GC/MS) methods have been developed to resolve benzene, benzophenone, anthracene, fluorenone, and their respective stable isotope analogs from other components by gas chromatography. The ratio of stable isotope-labeled material to natural isotopic abundance compounds is determined from the mass spectra averaged across the chromatographic peak. Both total ion and selective ion chromatographic approaches were used for relative data and comparison. DOE

N90-17842# Rochester Univ., NY. Dept. of Chemistry.
PHOTOINDUCED ELECTRON TRANSFER PROCESSES IN HOMOGENEOUS AND MICROHETEROGENEOUS SOLUTIONS
David G. Whitten Dec. 1989 9 p
(Contract DE-FG02-86ER-13504)
(DE90-006048; DOE/ER-13504/4) Avail: NTIS HC A02/MF A01

During the present project period we have made major progress on our studies of photochemical electron transfer-induced fragmentation of organic electron donors. We have investigated a number of facets of this reactivity, and planned work for the future involves a number of extensions of these as well. As we have shown in studies to date, reactivities in these reactions depend strongly upon the structure of the donor, structure of the acceptor, solvent and other conditions. For convenience in outlining the current results, this report will present our studies in terms of the electron donors used in the work. DOE

N90-17843# New Energy Development Organization, Tokyo (Japan).
SURVEY ON ENERGY CONVERSION OF CO2 GAS. APPROACH TO SOLUTION OF CO2 GAS PROBLEMS
Mar. 1989 233 p In JAPANESE; ENGLISH summary
(DE90-742055; NEDOJ-P-8812) Avail: NTIS (US Sales Only) HC A11/MF A02

The present state of the CO2 problems were generally understood, which were internationally investigated recently as one of the environmental problems, then the measures devised to deal with the problems were studied, especially the trend of the research to convert CO2 to fixed energy or other available materials, and their possibility was investigated. The reactivity of CO2 molecule seems not to be completely understood. Generally CO2 shows to react without any support by other energy or catalysts, provided reactivity of the object is completely high, however CO2 requires a lot of energy in the synthesis with object substrates. On the other hand, development of appropriate catalysts and saving of required energy are necessary for the reaction on the substrates with lower reactivity. Utilization of solar energy and others, never producing CO2 are desirable. As there are many researchs about CO2, such as separation from CO2 inclusion gases, biotically and chemically fixed CO2 conversion, concentrated and effective promotion to the research in practical use is required. DOE

N90-17844# State Univ. of New York, Buffalo. Dept. of Chemistry.
CHEMISTRY AT CLUSTERS, MICROSTRUCTURES AND SURFACES Final Report, 1 Dec. 1985 - 30 Nov. 1989
Thomas F. George Dec. 1989 19 p
(Contract N00014-86-K-0043)
(AD-A215842; UBUFFALO/DC/89/TR-120) Avail: NTIS HC A03/MF A01 CSCL 20/5

The objective has been to develop theoretical models and computational codes to describe chemical and physical phenomena associated with clusters, microstructures and surfaces, in order to gain a better understanding of surface/solid-state chemistry and its role in applied areas such as catalysis and microelectronics. The approach has been to examine topics relevant to this objective, using techniques appropriate for molecular dynamics, spectroscopy and electronic structure. The following nine topics have been studied: (1) clusters, with emphasis on geometry, stability, spectroscopy and reactions; (2) infrared-laser-excited adspecies with emphasis on energy and phase relaxation and desorption; (3) ultraviolet-laser-induced chemical vapor deposition; (4) resonance fluorescence at flat metallic surfaces; (5) photochemistry at structured metallic surfaces, with emphasis on gratings and thin films; (6) phase-conjugated surfaces; (7) laser-induced reactions in solid matrices; (8) nonlinear optical processes in polymeric systems; and (9) molecular dynamics simulations. GRA

N90-17845# University of Southern California, Los Angeles. Dept. of Electrical Engineering.
PROCEEDINGS OF A WORKSHOP ON HIGHER-ORDER SPECTRAL ANALYSIS Final Report, 1 Jun. 1988 - 30 Sep. 1989
C. L. Nikias and Jerry M. Mendel 28 Nov. 1989 274 p Workshop held at Vail, CO, 28-30 Jun. 1989
(Contract N00014-88-J-1143)
(AD-A215849) Avail: NTIS HC A12/MF A01 CSCL 20/1

About 123 attendees from the United States, France, United Kingdom, Italy, Japan, and Israel participated in the Workshop on Higher-Order Spectral Analysis. Held in Vail, Colorado, the three day event turned out to be very successful in terms of participation and quality of contributions. The objective of the workshop was to provide a forum for discussion of new theories and methods for processing signals that are based on Higher-Order Spectra. The overwhelming response to its announcement, as well as the breadth and depth of contributions and informal discussions among participants, clearly established that higher-order spectra is a new and emerging technology in signal processing and is expanding rapidly. The workshop featured two tutorial sessions, two keynote addresses, one panel discussion and ten technical sessions. A total of fifty papers were presented. There were no parallel sessions at the workshop. The technical program was truly outstanding. In addition, the workshop provided a very relaxing atmosphere where many informal discussions took place. This final report describes the events and subject matter. GRA

N90-17846# Cincinnati Univ., OH. Dept. of Materials Science and Engineering.
NON-DESTRUCTIVE CHARACTERIZATION OF EPOXY/DICYANDIAMIDE INTERPHASES USING SURFACE-ENHANCED RAMAN SCATTERING Technical Report No. 2
F. J. Boerio and P. P. Hong 1 Dec. 1989 32 p Submitted for publication
(Contract N00014-89-J-1590)
(AD-A215894; TR-2) Avail: NTIS HC A03/MF A01 CSCL 20/5

Surface-enhanced Raman scattering (SERS) is a process in which the Raman scattering cross section of molecules adsorbed onto the surfaces of metals such as silver, copper, and, gold is increased by as much as six orders of magnitude compared to the cross section for normal Raman scattering from the bulk. However, the enhancement is short-range and is restricted to the first few layers of molecules adjacent to the surface. As a result, SERS can be used to characterize adsorption of organic compounds onto metals and can be used for non-destructive characterization of interphases between polymer films and metal substrates as long as the polymer films are not so thick that normal Raman scattering from the bulk of the film is more intense than SERS from the interphase. SERS spectra obtained from thin films of dicyandiamide (dicy) adsorbed from dilute solutions onto silver island films were characterized by very strong bands assigned to in-plane vibrations and very weak vibrations related to out-of-plane vibrations, indicating that dicy was adsorbed with a vertical configuration involving coordination through the nitrilo nitrogen atom. GRA

N90-17847# Kansas State Univ., Manhattan. Dept. of Chemistry.
STATE TO STATE KINETICS OF XeCl* Final Report
27 Nov. 1989 10 p
(Contract N00014-84-K-0162)
(AD-A215895) Avail: NTIS HC A02/MF A01 CSCL 07/4

The two- and three-body quenching of XeCl (B,C) by Xe and by mixtures of Xe with He, Ne, AR, and KR were measured at 300 K. Three-body quenching leads to Xe Cl* formation. The relaxation processes of the six Xe (6p) states in Xe, Kr, Ar, Ne, and He were characterized at 300K. Experiments were done to characterize the quenching rate constants and the product states from the reactions of these Xe (6p) states with chlorine and fluorine containing molecules. GRA

N90-17848# Army Chemical Research and Development Center, Aberdeen Proving Ground, MD.
THE EVAPORATION OF SESSILE DROPLETS. PART 1: THEORETICAL FACTORS FOR A TWO-COMPONENT SYSTEM Technical Report, Nov. 1979 - May 1988
Elwin C. Penski and Helen M. Walker Jul. 1989 32 p
(AD-A215946; CRDEC-TR-095) Avail: NTIS HC A03/MF A01 CSCL 07/4

The fundamental principles that need to be included in any analysis of the evaporation of a sessile droplet of a two-component solution are provided in this report. The equations needed to calculate the behavior of a sessile droplet of a two-component solution are integrated into a model. A computer program is provided, and a calculation with the model is compared with data for a sessile water droplet on an aluminum surface. GRA

N90-17849# Cincinnati Univ., OH. Dept. of Materials Science and Engineering.
SURFACE-ENHANCED RAMAN SCATTERING
F. J. Boerio 1 Dec. 1989 25 p Presented at the International Conference on Metallurgical, San Diego, CA, 17-21 Apr. 1989 Revised Submitted for publication
(Contract N00014-89-J-1590)
(AD-A215976; TR-1-Rev) Avail: NTIS HC A03/MF A01 CSCL 07/4

Surface-enhanced Raman scattering (SERS) is a process in which the Raman scattering cross section of molecules adsorbed onto the surfaces of metals such as silver, copper, and gold is increased by as much as six orders of magnitude. However, the enhancement is short-range and is restricted to the first few layers of molecules adjacent to the surface. As a result, SERS can be used to characterize adsorption of organic compounds onto metals and can be used for non-destructive characterization of interfaces between polymer films and metal substrates as long as the polymer films are not so thick that normal Raman scattering from the bulk of the film is more intense than SERS from the interface. SERS spectra were obtained from bilayers prepared by spin-coating thin films of polymers such as polystyrene onto silver island films and then overcoating them with much thicker films of a second polymer such as polystyrene sulfonate. The spectra were characteristic of the films adjacent to the silver and not the overlayers as long as the thickness of the films adjacent to the substrate was more than about 100 A in thickness. SERS spectra obtained from thick films of an acrylic adhesive spin-coated onto silver were identical to normal Raman spectra of salts of saccharin, a component of

the cure system, and to SERS spectra of saccharin, indicating that saccharin segregated to the adhesive/substrate interface and adsorbed onto the substrate by dissociation. GRA

N90-17850# Harvard Univ., Cambridge, MA. Dept. of Chemistry.
THE PHYSICAL-ORGANIC CHEMISTRY OF SURFACES, AND ITS RELEVANCE TO MOLECULAR RECOGNITION Interim Technical Report
George M. Whitesides and Hans Biebuyck Nov. 1989 22 p Submitted for publication Sponsored in part by NSF
(Contract N00014-86-K-0756)
(AD-A215987; TR-25) Avail: NTIS HC A02/MF A01 CSCL 07/4

Understanding the interactions between liquids and the surfaces of organic solids is important for the study of molecular recognition. One method for studying these interactions is based on a physical organic approach: formation of well characterized organic surfaces and comparison of the contact angles of liquids on these surfaces. The technique of self-assembly provides an excellent route for the syntheses of organic surfaces; alkanethiols, for example, self-assemble from solutions to form monolayers on gold. Properties of these monolayers, including their thickness and their wettability by water, can be controlled by manipulating the structure and functionality of the molecules used to form the monolayer. The wettability of monolayers on gold formed from HS(CH2)(n)CH3 or HS(CH2)110(CH2)(n)CH3, where n is the number of methylene groups, depends only on the composition the outermost 5 to 10 A angstroms of the monolayer. The wettability of monolayers formed from mixtures of HS(CH2)11CH3 and HS(CH2)21CH3 depends both on the structure of the outermost part of the monolayer and the structure of the liquid. These and other results suggest that this physical-organic approach has and will continue to provide valuable insight into molecular recognition. GRA

N90-17851# Harvard Univ., Cambridge, MA. Dept. of Chemistry.
THE SIZE OF THE ALKYL GROUP R IS THE PRINCIPAL FACTOR DETERMINING THE WETTABILITY OF SURFACE-FUNCTIONALIZED POLYETHYLENES (PE-CONHR AND PE-CO2R) BY WATER Interim Technical Report
Mark D. Wilson, Gregory S. Ferguson, and George M. Whitesides Nov. 1989 16 p Submitted for publication
(Contract N00014-86-K-0756)
(AD-A216007; TR-24) Avail: NTIS HC A02/MF A01 CSCL 07/6

Advancing contact angles Theta (a) were measured for a series of surface-functionalized polyethylene films bearing ester (-CO2C(n)H(2n+1))and amide (-CONH(n)H(2n+1)) groups having different sizes of alkyl group. The influence of the polar ester or amide functionality on Theta (a) is no longer detectable for alkyl groups having n less than or equal 6. The size of the alkyl group required to shield a polar functional group at the surface of the polymer from the contacting water inferred from these experiments is remarkably similar to that observed previously with the more highly ordered, self-assembled monolayers of omega-mercapto ethers (HS(CH2)16OC(n)H(2n+1)) on gold. GRA

N90-17852# State Univ. of New York, Buffalo. Dept. of Chemistry.
THE HUECKEL MODEL FOR SMALL METAL CLUSTERS. 4: ORBITAL PROPERTIES AND COHESIVE ENERGIES FOR MODEL CLUSTERS OF UP TO SEVERAL HUNDRED ATOMS
D. M. Lindsay, Youqi Wang (California Inst. of Tech., Pasadena.), and Thomas F. George Dec. 1989 40 p Submitted for publication Sponsored in part by City Univ. of New York
(Contract N00014-90-J-1193; NSF CHE-83-07164; NSF CHE-86-20274; NSF RII-83-05241)
(AD-A216161; UBUFFALO/DC/89/TR-1) Avail: NTIS HC A03/MF A01 CSCL 07/4

We examine model cluster structures by applying the simple Hueckel method to spherically symmetric clusters whose atoms are constrained to occupy cubic (simply, body-centered or face-centered) and hcp lattice positions. The Hueckel orbitals are organized into energy shells, many of which remain well separated even at 500 to 600 atom cluster sizes. The classical droplet model provides a good fit to cluster atomization energies, which then correctly extrapolate to the bulk cohesive energy predicted by tight binding calculations. Energy level distributions for cubic lattice show that features characteristic of a tight binding solid become fully evident in clusters containing as few as 100 atoms. A particular example is the high density of states found for the Fermi level of bcc clusters, vestiges of which might suffice to confer on suitable materials an enhance electrical conductivity. GRA

N90-17853# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
EVALUATION OF PLATINUM SILICIDE AND INDIUM ANTIMONIDE AS DETECTOR MATERIALS FOR SPACE-BASED REMOTE SENSING IN THE 3.0-TO-5.0 MICROMETER WAVELENGTH BAND M.S. Thesis
Ralph R. Sandys Dec. 1989 155 p
(AD-A216182; AFIT/GSO/ENP/ENS/89D-6) Avail: NTIS HC A08/MF A01 CSCL 17/5

Platinum Silicide and Indium Antimonide are evaluated as detector materials for space-based remote sensing of man-made ground targets in the 3.0-to-5.0 micron band. The evaluation compares a generic target to each of four backgrounds including vegetation, snow, sand, and soil. A spectral count rate for the target and each background is calculated taking into account the material's quantum efficiency, the source's reflectivity/emissivity, and the atmospheric transmission. A baseline case and nine excursions were examined. The baseline case has the target and backgrounds at a temperature of 298 K. The atmospheric transmission used in this case is for a rural setting with a 23 km visibility and a vertical path through the atmosphere. The nine additional cases are produced by varying the baseline one parameter at a time - target and background temperatures, target reflectivity, and atmospheric humidity. Based on these cases, an evaluation was made of the remote sensing potential of each material as the various parameters were varied. In addition, an assessment was made of the multiband remote sensing possibilities in the 3.0-to-5.0 micron band available for each material. GRA

N90-17854# Pennsylvania State Univ., University Park. Dept. of Materials Science and Engineering.
HYDROGEN SULFIDE EFFECT ON HYDROGEN ENTRY INTO IRON: A MECHANISTIC STUDY Interim Report, 15 Dec. 1988 - 14 Dec. 1989
H. W. Pickering Dec. 1989 44 p
(Contract N00014-84-K-0201)
(AD-A216214) Avail: NTIS HC A03/MF A01 CSCL 07/4

The recently developed I-P-Z model is modified in order to analyze the observed enhanced permeation of hydrogen that occurs in the presence of hydrogen sulfide during cathodic hydrogen charging of iron. The modification accounts for the fact that the energy of adsorption becomes coverage dependent at the higher coverages and affects the hydrogen evolution reaction (h.e.r.) in the presence of H2S. Charging experiments were performed on Ferrovac E-Iron membranes 0.5 mm thick using a Devanathan-Stachurski cell in deaerated, preelectrolyzed solutions made from 0.1M HClO4 and 0.1M NaClO4 with pH values of 1 and 2. The transfer coefficient, alpha, exchange current density, i sub o, thickness dependent absorption-adsorption rate constant k, recombination rate constant, k sub 3, surface hydrogen coverage, Theta sub H, and discharge rate constant, k1 superscript o, were obtained by application of the model to the experimental results. As a result, the role of H2S was clarified. While Theta sub H is increased in the presence of H2S, the overpotential, eta, is decreased consistent with an observed increase in alpha, and the increased H entry is found to be the result of a decreased k sub 3 as well as the increased alpha. In addition, a very important relationship has been derived that will enable the calculation of the absorption, K sub abs, and adsorption, K sub ads, rate constants from the electrochemical permeation results for different membrane thicknesses. GRA

N90-17855# Physical Sciences, Inc., Andover, MA.
CHARACTERIZATION OF TETRAHYDROGEN VIA STATE-SELECTED EXCITATION OF H2 Final Report, 5 Sep. 1986 - 5 Mar. 1989
W. J. Marinelli, A. M. Woodward, and W. J. Kessler Nov. 1989 82 p
(Contract F04611-86-C-0077)
(AD-A216239; PSI-1018/TR-924; AL-TR-89-068) Avail: NTIS HC A05/MF A01 CSCL 07/4

The initial effort to detect tetrahydrogen formed in a supersonic of jet expansion was unsuccessful; the lifetime of tetrahydrogen was too short to permit detection. A study of the high spin quintet nitrogen system was also conducted. Production of the A'-state was observed from energy pooling of triplet A-state molecules. Based on simple kinetic arguments, an upper limit of the lifetime of the A'-state was set at 0.3 ms. GRA

N90-17856# California Inst. of Tech., Pasadena. Aeronautical Labs.
CHEMICAL REACTIONS IN TURBULENT MIXING FLOWS Annual Report, 16 Apr. 1988 - 15 Apr. 1989
Paul E. Dimotakis, James E. Broadwell, and Anthony Leonard 15 Oct. 1989 147 p
(Contract GRI-5087-260-2467; AF-AFOSR-0155-88; AF-AFOSR-0213-83; AF Proj. 2308)
(AD-A216273; AFOSR-89-1690TR) Avail: NTIS HC A07/MF A01 CSCL 21/2

The purpose of this research was to conduct fundamental investigations of turbulent mixing chemical reactions and combustion processes in turbulent, subsonic supersonic flows. This program is comprised of several efforts. In particular, an experimental effort, an analytical effort, a modeling effort, a computational effort and a diagnostics development and data acquisition effort (the latter as dictated by specific needs of the experimental part of the overall program). The approach was to carry out a series of detailed theoretical and experimental studies primarily in two well defined, fundamentally important flow fields: Free shear layers and axisymmetric jets. To elucidate molecular transport effects, experiments, and theory concern themselves with both liquids and gases. Modeling efforts have been focused on both shear layers and turbulent jets with an effort to include the physics of the molecular transport processes, as well as formulations of models that permit the full chemical kinetics of the combustion process to be incorporated. The recent analytical efforts have concentrated on a hydrodynamic analysis of the stability of compressible shear layers. The computational studies are, at present, focused at fundamental issues pertaining to the computational simulation of both compressible and incompressible flows. GRA

N90-17857# Pennsylvania State Univ., University Park. Dept. of Materials Science and Engineering.
A REVIEW OF THE MECHANISM AND KINETICS OF ELECTROCHEMICAL HYDROGEN ENTRY AND DEGRADATION OF METALLIC SYSTEMS Annual Report, 15 Dec. 1988 - 14 Dec. 1989
Howard W. Pickering and Rajan N. Iyer Jan. 1990 57 p
(Contract N00014-84-K-0201)
(AD-A216671) Avail: NTIS HC A04/MF A01 CSCL 07/4

A review of the mechanism and kinetics electrochemical hydrogen entry and degradation of metallic systems is presented. The partitioning of the discharged hydrogen into molecular hydrogen evolving on the metallic surface and atomic hydrogen entering into a metallic material is considered. A rigorous model has been developed that yields the surface hydrogen coverage, the surface coverage-dependent transfer coefficient of the hydrogen evolution reaction (h.e.r.), and other parameters under a variety of experimental conditions from the permeation data. Further, the catalytic behavior which is quantified by the adsorption rate constant, are for the first time determinable by applying the model to the permeation data for various membrane thicknesses. Use of these parameters for analyzing the vulnerability of a solid metallic material to hydrogen entry and subsequent embrittlement is discussed. The model can also successfully analyze the effects of poisons, such as Hydrogen sulfide, on hydrogen entry, and the more complex case of hydrogen entry when the metal is covered with a film on its surface. GRA

N90-17916*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
COMBUSTION PROCESS SCIENCE AND TECHNOLOGY Abstract Only
Robert R. Hale *In its* Proceedings of the Second Noncontact Temperature Measurement Workshop 1 Jun. 1989 p 220 (For primary document see N90-17894 10-31)
Avail: NTIS HC A16/MF A03 CSCL 07D

N90-17925*# Purdue Univ., West Lafayette, IN. School of Mechanical Engineering.
MATERIALS THERMAL AND THERMORADIATIVE PROPERTIES/CHARACTERIZATION TECHNOLOGY
D. P. DeWitt and C. Y. Ho *In* JPL, Proceedings of the Second Noncontact Temperature Measurement Workshop 1 Jun. 1989 p 303-316 (For primary document see N90-17894 10-31)
Avail: NTIS HC A16/MF A03 CSCL 07D

26 METALLIC MATERIALS

Includes physical, chemical, and mechanical properties of metals, e.g., corrosion; and metallurgy.

N90-17858# Technical Research Centre of Finland, Helsinki. Metals Lab.
HYDROGEN EMBRITTLEMENT OF TITANIUM AND ITS ALLOYS
Irina Aho-Mantila and Markku Kemppainen Mar. 1988 45 p
Sponsored in part by Industrial Power Co. Ltd., Helsinki, Finland
(DE90-602366; YJT-88-03) Avail: NTIS (US Sales Only) HC A03/MF A01

Titanium is one of the possible canister materials for spent nuclear fuel. It is determined whether the hydrogen embrittlement of titanium could be a possible deterioration mechanism of titanium canisters. This experimental study is a continuation of the literature review made earlier. According to the literature study, mechanical properties of titanium are not much affected by hydrogen when tested by smooth specimens. The experimental results carried out with hydrogen charged specimens support this conclusion. The studied hydrogen contents were as received, 100 ppm, 200 ppm, 400 ppm and 700 ppm and the studied titanium specimens were of ASTM Grades 2 and 12. Test methods were slow strain rate test and constant load test. Hydrogen embrittlement of titanium occurs with slow strain rates or as a sustained load cracking. Even though the mechanical properties of titanium specimens were not much affected by hydrogen, the narrow brittle zone on the fracture surfaces widens with the slow strain rates and in long constant load tests this effect was most clear. More data- and experimental results are, however, needed in order to determine the effects of hydrogen on titanium canister. DOE

N90-17859# Societe Turbomeca, Bizanos (France). Dept. Materiaux Techniques Associes.
CHARACTERIZATION OF THE 6242 Si ALLOY. CENTRIFUGAL WHEEL IN CONVENTIONAL FORGING [CARACTERISATION DE L'ALLIAGE 6242 SI: ROUET CENTRIFUGE EN FORGEAGE CONVENTIONNEL]
10 May 1989 49 p In FRENCH
(Rept-NT-3967; ETN-90-96104) Avail: NTIS HC A03/MF A01

The analysis of two Ti alloy specimens are a reference for the optimization of the thermomechanical processing for a category of isothermal forging. The thermal processing includes solution treatment at 995 C or 980 C with 2 hr air cooling. It is found that the alpha globular structure is strongly dependent on the solution temperature. A faster tempering procedure should be favorable to a more homogeneous structure. ESA

N90-17860# Construcciones Aeronauticas S.A., Madrid (Spain). Subdireccion de Investigacion y Desarrollo de Tecnologia y Materiales.
TENSILE MECHANICAL PROPERTIES IN FLAT SPECIMENS OF 7150-T7751 [PROPIEDADES MECANICAS DE TRACCION EN PROBETAS PLANAS DE 7150-T7751]
L. E. Lopez 4 Nov. 1988 7 p In SPANISH
(INFORME-I-296/88; ETN-90-96182) Avail: NTIS HC A02/MF A01

Aluminum alloys used in aircraft construction are tested to study the effect of thermal cycling on tensile properties. Tests were made using specimens with different thickness. It is found that hardness dininishes and conductivity increases with exposure time to 155C treatment. The tensile properties are better than required in the specifications. ESA

N90-17861# Construcciones Aeronauticas S.A., Madrid (Spain). Subdireccion de Investigacion y Desarrollo de Tecnologia y Materiales.
COMPARATIVE ANALYSIS BETWEEN THE MECHANICAL PROPERTIES OF CONVENTIONAL ALLOYS AND Al-Li [ANALISIS COMPARATIVO ENTRE LAS PROPIEDADES MECANICAS DE ALEACIONES CONVENCIONALES Y ALEACIONES DE ALUMINIO-LITIO]
L. E. Lopez 13 Jan. 1989 9 p In SPANISH
(INFORME-DT-317/89; ETN-90-96184) Avail: NTIS HC A02/MF A01

The mechanical properties of the conventional alloys 2024 and 7075 were compared to the properties al Al-Li alloys including 2091, 8090C and 2090. The analysis of the results allows a table of possible substitutions to be obtained. Equivalent properties replacements are indicated for the tested conventional alloy. ESA

N90-17862# Oak Ridge National Lab., TN. Chemical Technology Div.
PLATING NICKEL-63 ON COPPER COUPONS
M. Petek, J. S. Wike, B. P. Phillips, and C. A. Sampson Dec. 1989 27 p
(Contract DE-AC05-84OR-21400)
(DE90-005023; ORNL/TM-10989) Avail: NTIS HC A03/MF A01

A method suitable for hot cell operations was developed to electroplate (63)Ni-enriched nickel on copper. Efficient utilization of the limited quantity of available radioisotope material was a primary concern. The isotope was prepared by neutron irradiation of nickel metal enriched in (62)Ni by the reaction (62)Ni + n = (63)Ni + gamma. The irradiated nickel was dissolved in HCl, and the solution was passed through an ion exchanger to eliminate traces of radioactive isotopes cogenerated from the impurities present in the sample. The purified nickel chloride was converted to sulfate, and a stock solution was prepared. The electroplating solution consisted of ammonium sulfate, ammonia, and a small amount of a surfactant, to which an aliquot of the (63)Ni stock solution was added. The unused portion of nickel sulfate would be regenerated from this solution by merely heating to remove all the other components. Uniform, well adherent deposits were obtained. From the original 4.67 g of nickel enriched in (63)Ni, 2.6 g was plated on copper, 1.52 g remained as unused nickel sulfate, and 0.55 g was lost in the process. DOE

N90-17863# International Centre for Theoretical Physics, Trieste (Italy).
STRAIN INDUCED AMORPHIZATION OF ALUMINIUM BY MANGANESE IMPLANTATION
C. A. Majid Jun. 1989 31 p Submitted for publication
(DE90-607259; IC-89/121) Avail: NTIS (US Sales Only) HC A03/MF A01

The structural modifications of aluminum thin films implanted with manganese ions at room temperature, have been reported. These studies were performed using a two circle x ray powder diffractometer. The method of x ray line profile analysis was used to determine strain. As a consequence of ion bombardment, the aluminum lattice was found to undergo distortions. The maximum value of the atomic displacement U(sub st) was found to be 0.14 + or - 0.01 A, and the maximum value of the root mean square strain was noted to be 1.05 + or - 0.15 x 10(exp -3). The lattice constant alpha(sub 0) of Al was found to decrease. The decrease in alpha(sub 0) was noted to be about 0.12 at percent. DOE

N90-17864# Oak Ridge National Lab., TN. Metals and Ceramics Div.
ENVIRONMENTAL EMBRITTLEMENT: A MAJOR CAUSE FOR LOW DUCTILITY OF ORDERED INTERMETALLICS
C. T. Liu and C. G. McKamey Dec. 1989 19 p Presented at the Conference on High Temperature Aluminides and Intermetallics, Indianapolis, IN, 1-5 Oct. 1989
(Contract DE-AC05-84OR-21400)
(DE90-006161; CONF-8910117-1) Avail: NTIS HC A03/MF A01

A brief review is provided of recent research on the effect of test environment on ductility and fracture in ordered intermetallics. A number of intermetallics including FeAl, Fe3Al, Co3Ti and Ni3Al alloys show distinctly room temperature lower ductilities when tested in air than in vacuum or controlled environments. The environmental embrittlement involves the reaction of water vapor in the air with reactive elements (such as aluminum) in the intermetallics and the resulting generation of atomic hydrogen that drives into the metals and promotes brittle fracture along grain boundaries or cleavage planes. It was demonstrated that, in some alloy systems, the embrittlement can be alleviated or totally eliminated by alloying additions. The test environment can also affect the ductility of ordered intermetallics at elevated temperatures, but the embrittling mechanism and agent are quite different. The study of environmental effects has led to better understanding of brittle fracture and low ductilities, thereby providing a new direction for alloy design of ductile ordered intermetallics for structural use. DOE

N90-17865# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
EFFECT OF A SINGLE OVERLOAD UPON FATIGUE CRACK GROWTH IN AN ALUMINUM-LITHIUM ALLOY M.S. Thesis
Albert S. Perkins Dec. 1989 205 p
(AD-A216183; AFIT/GAE/ENY/89D-27) Avail: NTIS HC A10/MF A02 CSCL 11/6

The fundamental goal of this thesis was to investigate the effect of a single overload upon the behavior of fatigue crack growth in the aluminum-lithium alloy designated AlLi 2091. Specimens used in this study were compact tension (CT) specimens; crack growth was produced by a cyclic loading of constant load ration (0.1) and a constant maximum stress intensity factor, punctuated with periodic (single) overloads. Crack growth in the CT specimens was monitored by a variety of different instrumentations. Crack length was tracked using the electric potential (EP) method. Far-field measurements were taken via a clip gage (at the specimen mouth). Optical measurements, taken by travelling microscope, allowed for the correction of the EP crack length monitoring during the test if needed. In addition, load-displacement measurements were taken at a set of microhardness indents near the crack tip with a laser interferometric displacement gage (IDG). These near field measurements were compared to the closure measured by the clip gage, a far-field device. GRA

N90-17866# Naval Air Development Center, Warminster, PA. Dept. of Air Vehicle and Crew Systems Technology.
SURFACE MODIFICATION OF STEELS AND ALUMINUM ALLOYS TO CONTROL CORROSION AND HYDROGEN EMBRITTLEMENT. PART 1: CHEMICAL METHODS Final Report, Sep. 1983 - Dec. 1986
David A. Berman, Richard C. Paciej, and Vinod S. Agarwala 1 May 1989 37 p
(AD-A216272; NADC-89048-60-Pt-1) Avail: NTIS HC A03/MF A01 CSCL 11/6

Surface modification to control corrosion and/or hydrogen

embrittlement is approached in two ways: (1) treatment of the surface by chemicals, and (2) alteration of the electroplating process. This report describes the chemical modification of surfaces. Both a ferrocene derivative and a silane are used to prepare covalently bonded thin films on steels and aluminum alloys. The ferrocene should act as an electron reservoir whereas the silane should act as a barrier. Electrochemical properties were measured using potentiodynamic polarization and electrochemical impedance spectroscopy techniques. It was shown that the steels and an aluminum alloy which have good oxide coatings were covered more completely with the ferrocene than were carbon steels. Changes in potentiodynamic polarization scans indicated corrosion protection by the ferrocene coating on 4340 steel but not on 1018 steel. Electrochemical impedance measurements showed corrosion protection by the ferrocene coating on 7075-T6 aluminum. The electrochemical tests indicated that the silane gave corrosion protection to both 4130 and 1018 steel as well as to 7075-T6 aluminum. GRA

N90-17867# Rensselaer Polytechnic Inst., Troy, NY. Dept. of Physics.

COMPUTER SIMULATION OF ELECTROMIGRATION IN THIN FILMS Final Technical Report, Nov. 1987 - Oct. 1988

H. B. Huntington, P. P. Meng, and Y.-T. Shy Oct. 1989 21 p
(Contract F30602-81-C-0193; AF Proj. 2336)
(AD-A216382; RADC-TR-89-214) Avail: NTIS HC A02/MF A01 CSCL 11/6

Computational results of modelling electromigration in metal stripes without passivation but with reasonably realistic grain and grain-boundary configurations representing both unannealed and annealed strips have shown moderate reductions in a measure of damage by electromigration in the annealed case. GRA

N90-17868*# Pratt and Whitney Aircraft, East Hartford, CT. Engineering Div.

MATE (MATERIALS FOR ADVANCED TURBINE ENGINES) PROGRAM, PROJECT 3. VOLUME 2: DESIGN, FABRICATION AND EVALUATION OF AN OXIDE DISPERSION STRENGTHENED SHEET ALLOY COMBUSTOR LINER Final Report

S. Bose and K. D. Sheffler Feb. 1988 9 p
(Contract NAS3-20072)
(NASA-CR-180892; NAS 1.26:180892; PWA-5574-223-Vol-2)
Avail: NTIS HC A02/MF A01 CSCL 11F

The suitability of wrought oxide dispersion strengthened (ODS) superalloy sheet for gas turbine engine combustor applications was evaluated. Two yttria (Y2O3) dispersion strengthened alloys were evaluated; Incoloy MA956 and Haynes Development Alloy (HDA) 8077 (NiCrAl base). Preliminary tests showed both alloys to be potentially viable combustor materials, with neither alloy exhibiting a significant advantage over the other. MA956 was selected as the final alloy based on manufacturing reproducibility for evaluation as a burner liner. A hybrid PW2037 inner burner liner containing MA956 and Hastelloy X components and using a louvered configuration was designed and constructed. The louvered configuration was chosen because of field experience and compatibility with the bill of material PW2037 design. The simulated flight cycle for the ground based engine tests consisted of 4.5 min idle, 1.5 min takeoff and intermediate conditions in a PW2037 engine with average uncorrected combustor exit temperature of 1527 C. Post test evaluation consisting of visual observations and fluorescent penetrant inspections was conducted after 500 cycles of testing. No loss of integrity in the burner liner was shown. Author

27 NONMETALLIC MATERIALS

Includes physical, chemical, and mechanical properties of plastics, elastomers, lubricants, polymers, textiles, adhesives, and ceramic materials.

For composite materials see *24 Composite Materials.*

N90-17869# State Univ. of New York, Buffalo. Dept. of Chemistry.

OPTICAL NUTATION IN POLYMERS IRRADIATED BY ULTRASHORT LASER PULSES

Xiao-Shen Li, D. L. Lin, Thomas F. George, and Xin Sun Sep. 1989 26 p
(Contract N00014-86-K-0043)
(AD-A212927; UBUFFALO/DC/89/TR-111) Avail: NTIS HC A03/MF A01 CSCL 20/5

The transient behavior of the optical susceptibility of polydiacetylene induced by an ultrafast pump field is investigated. Within a two-level model which includes phonon effects phenomenologically, an analytical expression for the nonlinear susceptibility is obtained. In addition to spectral hole burning, the novel phenomenon of optical nutation was found. Both the nutation and the shape of the hole depend sensitively on the detuning between the exciton frequency and the sum of the pump field and the phonon mode frequencies. The electronic state and phonon-mediated optical Stark blue shift are also found in this model. The results are in qualitative agreement with experiments and indicate that the steady state approximation is reliable only when the pulse of the pump field is longer than several exciton lifetimes. GRA

N90-17870# Ballistic Research Labs., Aberdeen Proving Ground, MD.

CONTROL OF TITANIUM DIBORIDE SHS REACTIONS BY INERT DILUTIONS AND MECHANICAL CONSTRAINT Final Report

Thomas Kottke, Laszlo J. Kecskes, and Andrus Niiler Sep. 1989 27 p
(AD-A214378; BRL-MR-3793) Avail: NTIS HC A03/MF A01 CSCL 11/2

Self Propagating High Temperature Synthesis (SHS) is a relatively new process used to produce high technology ceramic materials. This method involves solid combustion reactions of elemental powders and is characterized by synthesis propagation velocities on the order of a centimeter per second and reaction temperatures well in excess of 2000 C. One advantage of the SHS process is that essentially all the heat energy required for the synthesis of the ceramic material is supplied by the exothermic solid combustion reaction. Reaction propagation velocities, material loss and post-reaction temperature were controlled in titanium diboride samples by inert diluent addition and mechanical constraint of the reacting samples. An order-of-magnitude variation in propagation velocities was observed. The temperatures and amounts of lost material vary inversely with the diluent concentrations and degree of constraint. The consequences of this ability to control the reaction to ceramics processing by SHS are discussed. GRA

N90-17871# Construcciones Aeronauticas S.A., Madrid (Spain). Subdireccion de Investigacion y Desarrollo de Tecnologia y Materiales.

SIMPLE SHEAR TESTS OF THE FMI 23.5.06 ADHESIVE CURED AT LOW PRESSURE (12 PSI) [ENSAYOS DE CORTADURA SIMPLE DEL ADHESIVO FM123.5.06, CURADO A BAJA PRESION (12 PSI)]

C. Serrano 7 Nov. 1988 7 p In SPANISH
(INFORME-I-298/88; ETN-90-96183) Avail: NTIS HC A02/MF A01

Specimens from a unidirectional carbon fiber bead panel used in aircrafts structures, adhesive bonded with the tested material, were tested after ultrasonic inspection. A large loss of shear resistance (93 percent) is found for specimens subjected to accelerated aging (temperature and humidity). ESA

N90-17872# Construcciones Aeronauticas S.A., Madrid (Spain). Subdireccion de Investigacion y Desarrollo de Tecnologia y Materiales.
STUDY OF DEFECT DISTRIBUTION IN MANUFACTURING TEST E8 NO. 2 (PROGRAM A-330/340) [ESTUDIO DE DISTRIBUCION DE DEFECTOS EN ENSAYO FABRICABILIDAD E8 NO2 (PROGRAMA A-330/340)]
I. Fernandez and J. Bravo 14 Jul. 1989 16 p In SPANISH
(INFORME-I-366/89; ETN-90-96186) Avail: NTIS HC A03/MF A01

Defects were analyzed in 9 samples of carbon fiber reinforced plastics from aircraft construction components. The zones observed correspond to the regions where the nondestructive tests detected the existence of defects. A graduated optical microscope was used to observe and measure the defects. Most typical defects found are delamination and longitudinal cracks. Transversal cracks starting in + or - 45 deg layers and traversing all 0 deg oriented layers are also observed. ESA

N90-17873# Construcciones Aeronauticas S.A., Madrid (Spain). Subdireccion de Investigacion y Desarollo de Tecnologia y Materiales.
PRESSURE AIR TIGHTNESS TESTS OF LAMINATED PANELS FOR WING LEADING EDGE HEAT SHIELDS [ENSAYO DE ESTANQUEIDAD AL AIRE A PRESION DE PANELES LAMINADOS PARA HEAT SHIELD DE BORDE DE ATAQUE]
B. Sainz and A. Buendia 25 Jul. 1989 4 p In SPANISH
(INFORME-I-377/89; ETN-90-96187) Avail: NTIS HC A01/MF A01

Preimpregnated laminates of glass fiber/phenolic resins were tested using 80 by 80 mm specimens of different ply composition and orientation. All tests show good air tightness up to 7 psi. ESA

N90-17874# Materials Research Labs., Ascot Vale (Australia).
PRINCIPLES AND FORMULATION OF SOLAR REFLECTING AND LOW INFRARED EMITTING COATINGS FOR DEFENCE USE
Lindsay Vernon Wake 1989 21 p
(MRL-TR-89-2; ARL-005-687) Avail: NTIS HC A03/MF A01

Coatings may be formulated to increase solar heat reflection for paint colors required on defense equipment. Pigments in coatings have a strong influence on the absorption and reflection of radiation in the visible and infrared regions. Dark pigments, such as those in camouflage patterns, are often highly absorptive in the near infrared region resulting in excessive heating of military equipment when exposed to sunlight. Resins also absorb and emit radiation, frequently in the thermal infrared region. Coatings may be formulated to reduce the energy emitted in the thermal infrared region for a given surface temperature. The formulation of coatings to reduce heat buildup, prolong service life, and control infrared emission from defense equipment are covered. A number of service requests are cited to illustrate solar and infrared requirements. Author

N90-17875*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
DETERMINATION OF THE THERMAL STABILITY OF PERFLUOROALKYLETHERS
Larry S. Helmick and William R. Jones, Jr. Feb. 1990 21 p Proposed for presentation at the Japan International Tribology Conference, Nagaya, Japan, 29 Oct. - 1 Nov. 1990; sponsored by Japan Society of Tribologists
(NASA-TM-102493; E-5211; NAS 1.15:102493) Avail: NTIS HC A03/MF A01 CSCL 11B

The thermal decomposition temperatures of several commercial and custom synthesized perfluoroalkylether fluids were determined with a computerized tensimeter. In general, the decomposition temperatures of the commercial fluids were all similar and significantly higher than those for custom synthesized fluids. Correlation of the decomposition temperatures with the molecular structures of the primary components of the commercial fluids revealed that the stability of the fluids is not affected by intrinsic factors such as carbon chain length, branching, or cumulated difluoroformal groups. Instead, correlation with extrinsic factors revealed that the stability may be limited by the presence of small quantities of thermally unstable material and/or chlorine-containing material arising from the use of chlorine-containing solvents during synthesis. Finally, correlation of decomposition temperatures with molecular weights for Demnum and Krytox fluids supports a chain cleavage reaction mechanism for Demnum fluids and an unzipping reaction mechanism for Krytox fluids. Author

N90-17876# Lawrence Livermore National Lab., CA.
STRUCTURE AND PROPERTIES OF RESORCINOL-FORMALDEHYDE GELS
Stephan A. Letts, Steven R. Buckley, Fung-Ming Kong, Edward F. Lindsey, and Margaret L. Sattler 22 Nov. 1989 5 p Presented at the Materials Research Society Fall Meeting, Boston, MA, 27 Nov. - 2 Dec. 1989 Submitted for publication
(Contract W-7405-eng-48)
(DE90-005201; UCRL-101307; CONF-891119-61) Avail: NTIS HC A01/MF A01

The condensation polymerization of resorcinol and formaldehyde catalized by sodium carbonate produces a sol that aggregates to form a gel. Using viscometry the effect of temperature and catalyst concentration on the sol-gel transition was investigated. At a solids concentration of 3 percent, gelation occurred in 1500 minutes. The rate of increase in viscosity was a function of both catalyst concentration and temperature. The structure of the gels was studied by freeze fracture TEM. In the sol phase the RF solutions contain particles of 5 to 20 nm diameter. After gelation the particles form a crosslinked network with a pore structure of 100 nm. DOE

N90-17877# Northwestern Univ., Evanston, IL.
STRUCTURAL AND FAST ION TRANSPORT PROPERTIES OF GLASSY AND AMORPHOUS MATERIALS Final Report
D. H. Whitmore and P. Georgopoulos Nov. 1989 9 p
(Contract DE-FG02-85ER-45198)
(DE90-005587; DOE/ER-45198/3) Avail: NTIS HC A02/MF A01

This research has dealt with ionic conductivity in two classes of electrolytes. Solid inorganic, as well as polymer. In the former case, a structural characterization study of the fast Ag(sup +) ion conducting glassy electrolyte Ag(0.25)Ge(0.19)Se(0.56) was undertaken by means of differential anomalous x ray scattering techniques. The Ag(+) ion transport behavior was probed with the aid of complex impedance spectroscopy and pulsed field gradient NMR measurements of the Ag(+) ion diffusivity. Evidence was found suggesting that short (3.1 to 3.5 A) Ag-Ag distances are present. The observed prefactor for conductivity suggests that the number of mobile Ag(+) ions in this glass is significantly less than expected from its stoichiometry. The transport property results were examined in the light of the structural findings and analyses were attempted in terms of some reasonable microscopic models. The other major aspect of this research, dealing with amorphous poly(ethylene glycol)-LiCF3SO3 electrolytes, involved measurements, via the pulsed field gradient NMR method, of the diffusivity of the polymer host, the cation (Li+) and the anion (CF3SO3-) in these complexes and the ionic conductivity, via complex impedance spectroscopy. Based on the conductivity prefactors, it appears that these amorphous polymer electrolytes exhibit classical Meyer-Nelder behavior; moreover, the ion transport results could be rationalized in terms of an ion association model (involving ion pairs and higher order aggregates). DOE

N90-17878# Argonne National Lab., IL. Materials Science Div.
ON THE SCALE OF DIFFUSION LENGTHS OBSERVABLE BY NEUTRON REFLECTION: APPLICATION TO POLYMERS
A. Karim, A. Mansour, Gian P. Felcher, and T. P. Russell (IBM Research Lab., San Jose, CA.) Dec. 1989 7 p Presented at the Materials Research Society Fall Meeting, Boston, MA, 27 Nov. - 2 Dec. 1989 Submitted for publication
(Contract W-31-109-eng-38)

(DE90-005645; CONF-891119-72) Avail: NTIS HC A02/MF A01

A systematic approach was applied to neutron reflectivity data to study interdiffusion across an interface. It is shown that with this technique it is possible to probe interface broadening from approximately 10 A to upward of 200 A, the upper limit being already within the range of observation of other techniques such as Rutherford backscattering spectrometry (RBS), forward recoil spectrometry (FRES) and secondary ions mass spectroscopy (SIMS). As example is analyzed the interdiffusion of a bilayered polymer system: a deuterated polystyrene (d-PS) layer on protonated polystyrene (h-PS). DOE

N90-17879# Akron Univ., OH. Polymer Engineering Center.
EFFECT OF OXYGEN ON THE TEAR STRENGTH OF ELASTOMERS
A. N. Gent and M. Hindi Nov. 1989 40 p
(Contract N00014-85-K-0222)
(AD-A215845; TR-21) Avail: NTIS HC A03/MF A01 CSCL 11/10

Rates of tearing under steady and intermittent loads wave measured for some representative elastomers. The rate depended strongly upon the load and also upon the environment. Tearing was strongly upon the load and also upon the environment. Tearing was much slower for SBR and BR vulcanizates in vacuo, especially at low loads, by a factor of up to 10X. For NR the effect was quite small by a factor of 2X at the most. Experiments were also carried out in the presence of thiophenol vapor, a radical trap. For NR, the effect was found only at high loads, when tearing was much slower, by a factor of about 10X. The improvement persisted after thiophenol was removed; it is attributed chemical modification of the vulcanizate. On the other hand, tearing of SBR was accelerated at all loads by thiophenol vapor, to the same degree as in air. Much smaller effects were found for a peroxide vulcanizate off SBR. It is concluded that the reactions of sulfur crosslinks with radical acceptors, including oxygen, lead to an increased rate of tearing in SBR. For BR and NR vulcanizates the situation is less clear, because of the smaller effect of oxygen in the first case and of thiophenol in the second. GRA

N90-17880# Texas A&M Univ., College Station. Dept. of Chemistry.
LUMINESCENCE PROBE STUDIES OF IONOMERS. PART 3: DISTRIBUTION OF DECAY RATE CONSTANTS FOR TRIS BIPYRIDYL RUTHENIUM(II) IN NAFION MEMBRANES
Jorge L. Colon and Charles R. Martin 2 Dec. 1989 41 p
(Contract N00014-82-K-0612)
(AD-A215885; TR-42) Avail: NTIS HC A03/MF A01 CSCL 07/4

Measurements of the luminescence lifetime of Tu (bpy)3-(2+)(bpy = 2,2'-bipyridine) in Nafion were used to probe the heterogeneity of -SO3H sites in the Nafion membrane. The decay kinetics of the probe ion are shown to depart from simple first-order behavior. Albery's model of a continuous distribution of rate constants is used to explain the decay kinetics. The results of these and related investigations indicated that the probe ions reside in sites with different local water activities. GRA

N90-17881# Florida Atlantic Univ., Boca Raton. Center for Marine Materials.
CHEMISTRY-STRUCTURE-PROPERTY INTERRELATIONSHIPS FOR CALCAREOUS DEPOSITS AS STAND-ALONE COATINGS Final Report, 15 Jan. 1986 - 30 Apr. 1989
William H. Hartt and Samual W. Smith 7 Dec. 1989 39 p
(Contract N00014-86-K-0144)
(AD-A216031) Avail: NTIS HC A03/MF A01 CSCL 11/3

Experiments were performed where 1018, A710, A537 and HY80 steel specimens of surface finish corresponding to 120, 320, 600 and 1500 polishing were polarized potentiostatically in seawater at -900 mv (SCE). The resulting calcareous deposits were analyzed with regard to structure, composition and morphology and found to be comprised of a relatively thin inner magnesium rich layer which formed initially and a subsequent, thicker, outer aragonite precipitate. The effect of this dual deposit structure, as well as variations in substrate, surface finish and electrolyte flow rate, upon current density decay was evaluated; and the observed trends are discussed in terms of the film formation process and cathodic protection utility. Calcareous deposits are a relatively unique type of surface film comprised primarily of calcium carbonate and magnesium hydroxide which precipitate upon cathodic surfaces in seawater. This occurs as a consequence of increased pH near the metal-electrolyte interface. The importance of calcareous deposits to the effective, efficient operation of marine cathodic protection systems is generally recognized by engineers and scientists concerned with cathodic protection in submerged marine environments. GRA

N90-17882# State Univ. of New York, Buffalo. Dept. of Chemistry.
NEW TYPE OF OPTICAL BISTABILITY IN POLYMERS MEDIATED BY PHONONS
Xiao-Shen Li, D. L. Lin, Thomas F. George, and Xin Sun (Center of Theoretical Physics, Beijing, China) Dec. 1989 20 p Submitted for publication
(Contracts N00014-90-J-1193; F49620-86-C-0009)
(AD-A216102; UBUFFALO/DC/89/TR-2) Avail: NTIS HC A02/MF A01 CSCL 20/5

A new type of optical bistability mediated by phonon and virtual exciton coupling is suggested for polymers. Numerical results with parameters pertaining to polydiacetylene-toluene sulfonate are given as an illustration. The stability of the steady-state solution is examined, and the physical mechanism responsible for the bistability is discussed. GRA

N90-17883# Cincinnati Univ., OH. Dept. of Materials Science and Engineering.
SURFACE-ENHANCED RAMAN SCATTERING FROM MODEL ACRYLIC ADHESIVE SYSTEMS
F. J. Boerio, P. P. Hong, P. J. Clark, and Y. Okamoto (Loctite Corp., Newington, CT.) 1 Dec. 1989 34 p Submitted for publication Sponsored in part by NSF and Loctite Corp., Newington, CT
(Contract N00014-89-J-1590)
(AD-A216117; TR-4) Avail: NTIS HC A03/MF A01 CSCL 11/1

Surface enhanced Raman scattering (SERS) was observed from a model acrylic adhesive deposited onto silver island films. SERS spectra of the adhesive system were very similar to SERS spectra of o-benzoic sulphimide (saccharin), a component of the curing system of the adhesive, and to normal Raman spectra of the sodium salt of saccharin. When saccharin was replaced in the curing system by benzoic acid, SERS spectra of the adhesive were similar to SERS spectra of benzoic acid and to normal Raman spectra of benzoic acid salts. The intensity of the SERS spectra was independent of the thickness of the adhesive films, indicating that the observed Raman signal was characteristic of the interface and not of the bulk of the films. These results demonstrate that saccharin and benzoic acid were preferentially adsorbed at the silver surface to form metal salts and that surface-enhanced Raman scattering can be used for non-destructive characterization of interphases between polymer films and SERS-active metal substrates as long as the films are not so thick that normal Raman scattering from the bulk is comparable in intensity to the SERS from the interphase. GRA

N90-17884# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
A FINITE ELEMENT ANALYSIS OF POROSITY EFFECTS ON MATERIALS M.S. Thesis
Paul R. Woodmansee Dec. 1989 152 p
(AD-A216225; AFIT/GAE/ENY/89D-41) Avail: NTIS HC A08/MF A01 CSCL 11/2

Porosity in materials greatly reduces the strength and load carrying characteristics of the material. Porosity is unavoidable in some materials (particularly ceramics) and is sometimes desirable for other reasons, such as radar reflection properties, diffusing a

fluid through a material, and adjusting the heat transfer properties. In the past, the effects of porosity on material properties, particularly a materials modulus of elasticity (Young's modulus), have been determined, by fitting test data to one of three theoretical equation forms (linear, empirical exponential, and Hassin's semi-empirical equation, whichever fit the data best). These analytical equations all require that the effects of porosity on material properties be determined experimentally for several cases, and then other cases can be extrapolated. This limits accurate prediction before a material can be fully analyzed and produced. In this thesis a finite element model using MSC/NASTRAN is developed that can numerically determine the material's modulus of elasticity using the limited information from one material sample. The model is three-dimensional, and simulates pores by placing small elements that are non-load bearing into the structure. These voids are randomly, and unevenly, distributed (using a Poisson distribution) to better simulate the response of a real porous material to a load. How much this porous model deforms can be used directly to calculate the porous modulus of elasticity. GRA

N90-17885# Ionic Atlanta, Inc., GA.
PLASMA AND ION FLUORINATION FOR CHEMICAL HARDENING OF SYNTHETIC RUBBERS Final Report, 30 Sep. 1988 - 30 Sep. 1989
Keith O. Legg Oct. 1989 76 p
(Contract DAAL04-88-C-0048; DA Proj. 1L6-65502-MM-40)
(AD-A216388; MTL-TR-89-92) Avail: NTIS HC A05/MF A01 CSCL 11/10

The purpose was to investigate ways of fluorinating the surfaces of rubber materials to reduce their susceptibility to wetting and permeation by chemical warfare agents. Nitrile, butyl, and neoprene rubbers were studied. Fluorination was accomplished by direct implantation of ions into the surface and by RF plasma fluorination with freon gases. The rubber materials were examined for contact angle of diethyl malonate (DEM) drops, critical surface tension, and DEM uptake, and were characterized microscopy and ESCA. Ion implantation led to embrittlement and cracking of the surfaces, causing more rapid wetting by DEM. Plasma fluorination tended to deposit a fluorocarbon film on the surface rather than to introduce fluorine into the material. Some of the fluorinated films exhibited greater DEM initial contact angles and slower absorption, although after three hours the absorption rate increased to that of the untreated rubbers. Hence, this treatment provided some temporary improvement, but it was insufficient for proper protection. GRA

N90-17886# Akron Univ., OH. Inst. of Polymer Science.
FUNDAMENTAL STUDIES OF TIME-DEPENDENT RESPONSE AND FRACTURE OF CROSS-LINKED POLYMERS Final Report
Frank N. Kelley, Maurice Morton, and Ernst vonMeerwell 30 Jun. 1989 148 p
(Contract F49620-86-C-0032)
(AD-A216694; AFOSR-89-1756TR) Avail: NTIS HC A07/MF A01 CSCL 11/9

The objectives of these studies are to determine the relationships of polymer structure, network topology and other microstructural features to time-dependent, small deformation properties such as creep and volume relaxation in thermosetting resins and to determine the relationships between polymer network structure and the fracture energy of thermosetting resins. Epoxy resins based on diglycidyl ether of bisphenol A (DGEBA) and diamino diphenyl sulfone (DDS) have been prepared using an homologous series of 5 prepolymer molecular weights and a stoichiometric ratio of reactants. Resultant networks were characterized as a graded series having increasing network chain lengths and decreasing T(g). The series of epoxy resins based on the diglycidyl ether of bisphenol A has been extensively investigated during and after curing. The degree of cure was monitored by four different methods: (1) density increase, (2) heat of reaction evolution, (3) glass temperature, T(g), increase, and (4) infrared absorption by the glycidyl ether group. The epoxy resins studied indicated that only a single reaction path was followed during the curing but the kinetics were, of course, highly temperature sensitive. GRA

28 PROPELLANTS AND FUELS

Includes rocket propellants, igniters, and oxidizers; their storage and handling procedures; and aircraft fuels.

For related information see also *07 Aircraft Propulsion and Power, 20 Spacecraft Propulsion and Power,* and *44 Energy Production and Conversion.*

N90-17887# Fluorochem, Inc., Azusa, CA.
RESEARCH IN ENERGETIC COMPOUNDS Interim Report, 12 Sep. 1988 - 11 Sep. 1989
R. D. Chapman, T. G. Archibald, and K. Baum 23 Oct. 1989 27 p
(Contract N00014-88-C-0536)
(AD-A214106; ONR-7-1) Avail: NTIS HC A03/MF A01 CSCL 19/1

During the 1960's, extensive research was supported on the synthesis of difluoramino compounds, with some incidental work on mixed nitro-difluoramino compounds. Emphasis was placed on the development of propellants rather than explosives. Although the difluoramino group is a potent oxidizing functional group, a problem in its utilization in explosives results from the fact that performance in this application is strongly related to oxygen balance. Univalent fluorine is half as effective as divalent oxygen in providing a stoichiometric combustion balance. Also, compounds with a high percentage of difluoramino groups are relatively sensitive to impact. These problems are minimized if only a few difluoramino groups, compared to nitro groups, are incorporated into a target molecule. GRA

N90-17888# Air Force Astronautics Lab., Edwards AFB, CA.
HEATING RATES IN A HIGH ENERGY PROPULSION SYSTEM (HEPS) ORBITAL TRANSFER VEHICLE (OTV) Final Report, Jun. - Aug. 1989
Rodney L. Miller Oct. 1989 27 p
(AD-A214354; AL-TR-89-056) Avail: NTIS HC A03/MF A01 CSCL 21/6

Rocket propulsion systems which use nuclear energy sources present unique challenges to the design, safety, and reliability of the concept. Since the vehicle and its components must operate in high radiation fields, nuclear heating and radiation effects must be determined and factored into the system design. The nuclear heating in a High Energy Propulsion System (HEPS) Orbital Transfer Vehicle (OTV) nozzle was analyzed. Using the FEMP2D (Finite Element, Multigroup, Pn, 2-Dimensional) code for an aluminum and carbon-carbon nozzle, it was determined that the heating contribution was found to be the significant source of heating for both materials. The overall heating rate in the aluminum nozzle (approx. 12 W/cc) was significantly higher than that found in the carbon-carbon nozzle (approx. 8 W/cc). GRA

N90-17889# Materials Research Labs., Ascot Vale (Australia). Explosives Div.
A PRELIMINARY ASSESSMENT OF 3-NITRO-1,2,4-TRIAZOL-5-ONE (NTO) AS AN INSENSITIVE HIGH EXPLOSIVE
Robert J. Spear, Craig N. Louey, and Mike G. Wolfson Jul. 1989 39 p
(AD-A215063; MRL-TR-89-18; DODA-AR-005-708) Avail: NTIS HC A03/MF A01 CSCL 19/1

A simple two-step method to produce NTO in high yield from semicarbazide hydrochloride has been defined. A free-flowing material with bulk density more than 0.9 g/ml has been produced by stirred aqueous recrystallization; surfactants were ineffective in altering crystal habit. Impact sensitiveness of NTO was higher than expected although apparent propagation ability is low. Ignitability under thermal and electrostatic stimuli is substantially lower than RDX. Experimental firings were conducted to assess explosive performance for charges pressed to about 90 percent TMD; velocity of detonation at 12.7 mm and 15.9 mm diameter was determined while detonation pressure (plate dent) and critical diameter were estimated. Performance at these diameters is somewhat lower than RDX. Moulding powders for 95:5 NTO/binder formulations were prepared from three commercial EVA resins

and a flame retardant polyphosphazene. All three NTO/EVA formulations were insensitive to impact. Recommendations for continuing studies on insensitive booster formulations have been made. GRA

N90-17890*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
FLUSH: A TOOL FOR THE DESIGN OF SLUSH HYDROGEN FLOW SYSTEMS
Terry L. Hardy Feb. 1990 71 p
(NASA-TM-102467; E-5255; NAS 1.15:102467) Avail: NTIS HC A04/MF A01 CSCL 21I

As part of the National Aerospace Plane Project an analytical model was developed to perform calculations for in-line transfer of solid-liquid mixtures of hydrogen. This code, called FLUSH, calculates pressure drop and solid fraction loss for the flow of slush hydrogen through pipe systems. The model solves the steady-state, one-dimensional equation of energy to obtain slush loss estimates. A description of the code is provided as well as a guide for users of the program. Preliminary results are also presented showing the anticipated degradation of slush hydrogen solid content for various piping systems. Author

N90-17891# Department of Energy, Washington, DC. Biofuels and Municipal Waste Technology Div.
HYDROGEN ENERGY COORDINATING COMMITTEE: SUMMARY OF DOE HYDROGEN PROGRAMS Annual Report, FY 1989
Jan. 1990 60 p
(DE90-004480; DOE/CE-0280) Avail: NTIS HC A04/MF A01

An ideal fuel for use in meeting the Nation's energy needs would be one that is virtually inexhaustible, clean burning, convenient, versatile, and free from foreign control. Hydrogen could be such a fuel, but it has limitations in that it is practically nonexistent in its free state and must be produced, consuming a primary energy source, such as gas, oil, or coal in the process. On the other hand, with existing technology for hydrogen utilization, hydrogen can serve as a fuel for all conventional energy uses, including industrial applications; electric power generation; and residential, commercial and transportation purposes. DOE

N90-17892# Southwest Research Inst., San Antonio, TX. Fuels and Lubricants Research Facility.
DEVELOPMENT OF FUEL WEAR TESTS USING THE CAMERON-PLINT HIGH-FREQUENCY RECIPROCATING MACHINE Interim Report, Mar. 1988 - May 1989
Mahendra D. Kanakia, John P. Cuellar, Jr., and Sidney J. Lestz May 1989 33 p
(Contract DAAK70-87-C-0043; DA Proj. 1L2-63001-D-150)
(AD-A216003; BFLRF-262) Avail: NTIS HC A03/MF A01 CSCL 21/4

The objectives of this program were to develop laboratory bench fuel-wear test methodology using JP-8 and to evaluate the effects of additives to improve load-carrying capacity of JP-8 for use in diesel-powered ground equipment. A laboratory test using the Cameron-Plint High-Frequency Reciprocating machine evaluated the effects of various chemical and physical parameters influencing the lubricity of the distillate fuels. The test conditions were determined sufficient to eliminate the effect of fluid physical properties such as viscosity. It was shown that the differences in the intrinsic lubricity of the fuels were due to small amounts of chemical additives. Under such conditions, the test can be used as a screening tool to find additives for enhancement of JP-8 lubricity. The test has potential to ascertain minimum lubricity level for diesel-powered ground equipment if these requirements are verified with field performance data and determined to be different from the Air Force JP-8 specifications. The dimensionless wear coefficients of Reference No. 2 diesel fuel were shown to be an order of magnitude lower than the jet fuels. In all cases, the wear rates of jet fuels and isoparaffinic solvents were improved by addition of a corrosion inhibitor or antiwear additive to match the lower wear rates of the diesel fuels. GRA

N90-17893# Southwest Research Inst., San Antonio, TX. Fuels and Lubricants Research Facility.
FUEL-ELASTOMER COMPATIBILITY STUDIES: RESULTS OF 80 C/14-DAY EXPOSURE EXPERIMENTS Interim Report, Nov. 1988 - Jul. 1989
George E. Fodor Jul. 1989 32 p
(Contract DAAK70-87-C-0043; DA Proj. 1L2-63001-D-150)
(AD-A216015; BFLRF-231) Avail: NTIS HC A03/MF A01 CSCL 21/4

Five collapsible, elastomer-coated fabric products were exposed to four middle distillate fuels and to a middle distillate fuel simulant. The coated fabrics were represented by a drum material, a pillow tank fabric and its seam section, and a berm liner with its seam section. Each of these samples was treated as individual materials. Compatibility of these products was studied under accelerated conditions, during which each elastomer was submerged in each fuel for 14 days at 80 C. The effects of the fuels on the elastomers and the effects of the elastomers on the fuels were evaluated using visual observations, photomicrographs, infrared spectroscopy, and measurement of hardness, color, gum, and water contents. GRA

29 MATERIALS PROCESSING

Includes space-based development of products and processes for commercial applications.
For biological materials see *55 Space Biology*.

N90-17895*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
NON-CONTACT TEMPERATURE MEASUREMENT REQUIREMENTS OF GROUND-BASED RESEARCH AND FLIGHT PROGRAMS AT JPL
E. H. Trinh *In its* Proceedings of the Second Noncontact Temperature Measurement Workshop 1 Jun. 1989 p 5-10 (For primary document see N90-17894 10-31)
Avail: NTIS HC A16/MF A03 CSCL 22A

N90-17897*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
MICROGRAVITY NONCONTACT TEMPERATURE REQUIREMENTS AT NASA LEWIS RESEARCH CENTER
G. Santoro *In* JPL, Proceedings of the Second Noncontact Temperature Measurement Workshop 1 Jun. 1989 p 19-32 (For primary document see N90-17894 10-31)
Avail: NTIS HC A16/MF A03 CSCL 22A

N90-17898*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
NON-CONTACT TEMPERATURE MEASUREMENT REQUIREMENTS
D. B. Higgins and W. K. Witherow *In* JPL, Proceedings of the Second Noncontact Temperature Measurement Workshop 1 Jun. 1989 p 33-38 (For primary document see N90-17894 10-31)
Avail: NTIS HC A16/MF A03 CSCL 22A

N90-17900*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
NON-CONTACT TEMPERATURE MEASUREMENTS IN SUPPORT OF MICROGRAVITY COMBUSTION EXPERIMENTS
Paul S. Greenberg *In* JPL, Proceedings of the Second Noncontact Temperature Measurement Workshop 1 Jun. 1989 p 50-59 (For primary document see N90-17894 10-31)
Avail: NTIS HC A16/MF A03 CSCL 22A

N90-17906*# Wyman-Gordon Co., North Grafton, MA.
NON-CONTACT TRUE TEMPERATURE MEASUREMENTS IN THE MICROGRAVITY ENVIRONMENT
Mansoor A. Khan, Charly Allemand, and Thomas W. Eagar (Massachusetts Inst. of Tech., Cambridge.) *In* JPL, Proceedings of the Second Noncontact Temperature Measurement Workshop 1 Jun. 1989 p 98-109 (For primary document see N90-17894

10-31)
Avail: NTIS HC A16/MF A03 CSCL 22A

N90-17912*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
NON-CONTACT TEMPERATURE MEASUREMENT OF A FALLING DROP
William Hofmeister, R. J. Bayuzick (Vanderbilt Univ., Nashville, TN.), and M. B. Robinson *In* JPL, Proceedings of the Second Noncontact Temperature Measurement Workshop 1 Jun. 1989 p 183-202 (For primary document see N90-17894 10-31)
Avail: NTIS HC A16/MF A03 CSCL 22A

N90-17913*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
POLYMERIC MATERIALS SCIENCE IN THE MICROGRAVITY ENVIRONMENT
Daniel R. Coulter *In its* Proceedings of the Second Noncontact Temperature Measurement Workshop 1 Jun. 1989 p 203-209 (For primary document see N90-17894 10-31)
Avail: NTIS HC A16/MF A03 CSCL 22A

N90-17918*# Vanderbilt Univ., Nashville, TN. Center for Microgravity Research and Applications.
NON-CONTACT TEMPERATURE REQUIREMENTS (NCTM) FOR DROP AND BUBBLE PHYSICS
Anthony B. Hmelo and Taylor G. Wang *In* JPL, Proceedings of the Second Noncontact Temperature Measurement Workshop 1 Jun. 1989 p 230-235 (For primary document see N90-17894 10-31)
Avail: NTIS HC A16/MF A03 CSCL 22A

31 ENGINEERING (GENERAL)

Includes vacuum technology; control engineering; display engineering; cryogenics; and fire prevention.

N90-17894*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
PROCEEDINGS OF THE SECOND NONCONTACT TEMPERATURE MEASUREMENT WORKSHOP
Robert R. Hale, ed. 1 Jun. 1989 359 p Workshop held in Pasadena, CA, 17-19 Jan. 1989
(Contract NAS7-918)
(NASA-CR-181289; NAS 1.26:181289; JPL-Publ-89-16; MCPF-695-009) Avail: NTIS HC A16/MF A03 CSCL 13B

The state of the art in noncontact temperature measurement (NCTM) technology was reviewed and the NCTM requirements of microgravity materials processing community identified. The workshop included technical presentations and discussions which ranged from research on advanced concepts for temperature measurement to laboratory research and development regarding measurement principles and state-of-the-art engineering practices for NCTM methodology in commercial and industrial applications. Technical presentations were made concerning: NCTM needs as perceived by several NASA centers, recent ground-based NCT, research and development of industry, NASA, academia, and selected national laboratories, work-in-progress communication, and technical issues of the implementation of temperature measurement in the space environment to facilitate future U.S. materials science investigations. For individual titles, see N90-17895 through N90-17926.

N90-17895*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
NON-CONTACT TEMPERATURE MEASUREMENT REQUIREMENTS OF GROUND-BASED RESEARCH AND FLIGHT PROGRAMS AT JPL **c29**
E. H. Trinh *In its* Proceedings of the Second Noncontact Temperature Measurement Workshop 1 Jun. 1989 p 5-10 (For primary document see N90-17894 10-31)
Avail: NTIS HC A16/MF A03 CSCL 22A

The Modular Containerless Processing Facility project is responsible for the development of flight equipment and of the accompanying scientific and technological research necessary to carry out containerless investigations in the low gravity of earth orbit. The requirement for sample temperature measurement is just one of the many physical properties determination needs that must be satisfied before the useful exploitation of low gravity and containerless experimentation techniques can be achieved. The specific implementation of temperature measurement for the ground-based research program is different from that of the flight hardware development project. The needs of the latter must also be differentiated according to the chronological order of the relevant space flight missions. Immediate demands of Spacelab instruments must be addressed by the adaptation of existing reliable technology to the special and restrictive on-orbit environment, while more advanced and yet unperfected techniques will be assigned to enterprises further in the future. The wide range of application of the containerless methods to the study of phenomena involving different states of matter and environmental conditions requires the satisfaction of a variety of boundary conditions through different approaches. An important issue to be resolved will be whether an integrated program dedicated to solve the problems of all the microgravity experimental effort will allow the solution of specific demands of existing as well as future flight equipment. Author

N90-17896*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
TEMPERATURE PROFILES IN HIGH GRADIENT FURNACES **c76**
A. L. Fripp, W. J. Debnam, G. A. Woodell, R. Berry, R. K. Crouch, and S. K. Sorokach (Planning Research Corp., Hampton, VA.) *In* JPL, Proceedings of the Second Noncontact Temperature Measurement Workshop 1 Jun. 1989 p 11-18 (For primary document see N90-17894 10-31)
Avail: NTIS HC A16/MF A03 CSCL 20L

Accurate temperature measurement of the furnace environment is very important in both the science and technology of crystal growth as well as many other materials processing operations. A high degree of both accuracy and precision is acutely needed in the directional solidification of compound semiconductors in which the temperature profiles control the freezing isotherm which, in turn, affects the composition of the growth with a concomitant feedback perturbation on the temperature profile. Directional solidification requires a furnace configuration that will transport heat through the sample being grown. A common growth procedure is the Bridgman Stockbarger technique which basically consists of a hot zone and a cold zone separated by an insulator. In a normal growth procedure the material, contained in an ampoule, is melted in the hot zone and is then moved relative to the furnace toward the cold zone and solidification occurs in the insulated region. Since the primary path of heat between the hot and cold zones is through the sample, both axial and radial temperature gradients exist in the region of the growth interface. There is a need to know the temperature profile of the growth furnace with the crystal that is to be grown as the thermal load. However it is usually not feasible to insert thermocouples inside an ampoule and thermocouples attached to the outside wall of the ampoule have both a thermal and a mechanical contact problem as well as a view angle problem. The objective is to present a technique of calibrating a furnace with a thermal load that closely matches the sample to be grown and to describe procedures that circumvent both the thermal and mechanical contact problems. Author

N90-17897*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
MICROGRAVITY NONCONTACT TEMPERATURE REQUIREMENTS AT NASA LEWIS RESEARCH CENTER **c29**
G. Santoro *In* JPL, Proceedings of the Second Noncontact Temperature Measurement Workshop 1 Jun. 1989 p 19-32 (For primary document see N90-17894 10-31)
Avail: NTIS HC A16/MF A03 CSCL 22A

NASA Lewis Research Center is currently supporting 66 microgravity science and applications projects. The 66 projects are separated into 23 flight projects and 43 ground-based projects.

The part of the NASA Lewis program dealing with flight experiments is divided into six areas: Combustion Science, Materials Science, Fluid Physics, Instrumentation/Equipment, Advanced Technology Development, and Space Station Multi-User Facility studies. The part of the NASA Lewis program dealing with ground-based experiments is coincidentally also divided into six areas: Electronic Materials, Combustion Science, Fluid Dynamics and Transport Phenomena, Metals and Alloys, Glasses and Ceramics, and Physics and Chemistry Experiments. Several purposes exist for ground-based experimenting. Preliminary information is necessary before a decision can be made for flight status, the short low gravity durations available in ground facilities are adequate for a particular study, or extensive ground-based research must be conducted to define and support the microgravity science endeavors contemplated for space. Not all of the 66 microgravity science and application projects at NASA Lewis have temperature requirements, but most do. Since space allocation does not permit a review of all the pertinent projects, a decision was made to restrict the coverage to the science flight projects, flight projects minus the advanced technology development, and multiuser facility efforts. Very little is lost by this decision as the types of temperature requirements for science flight projects can be considered representative of those for the ground-based projects. The noncontact temperature needs at NASA Lewis, as represented by the science flight projects are discussed by describing briefly the experiments themselves, by displaying an illustration of each experimental setup, and by specifying their temperature requisites. Author

N90-17898*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.

NON-CONTACT TEMPERATURE MEASUREMENT REQUIREMENTS **c29**

D. B. Higgins and W. K. Witherow *In* JPL, Proceedings of the Second Noncontact Temperature Measurement Workshop 1 Jun. 1989 p 33-38 (For primary document see N90-17894 10-31)
Avail: NTIS HC A16/MF A03 CSCL 22A

The Marshall Space Flight Center is involved with levitation experiments for Spacelab, Space Station, and drop tube/tower operations. These experiments have temperature measurement requirements, that of course must be non-contact in nature. The experiment modules involved are the Acoustic Levitator Furnace (ALF), and the Modular Electromagnetic Levitator (MEL). User requirements of the ALF and drop tube are presented. The center also has temperature measurement needs that are not microgravity experiment oriented, but rather are related to the propulsion system for the STS. This requirement will also be discussed. Author

N90-17899*# Oak Ridge National Lab., TN.

OPTICAL JOHNSON NOISE THERMOMETRY **c70**

R. L. Shepard, T. V. Blalock, L. C. Maxey, M. J. Roberts, and M. L. Simpson *In* JPL, Proceedings of the Second Noncontact Temperature Measurement Workshop 1 Jun. 1989 p 42-49 Previously announced as N89-20437 (For primary document see N90-17894 10-31)
(Contract DE-AC05-84OR-21400)
Avail: NTIS HC A16/MF A03 CSCL 20C

A concept is being explored that an optical analog of the electrical Johnson noise may be used to measure temperature independently of emissivity. The concept is that a laser beam may be modulated on reflection from a hot surface by interaction of the laser photons with the thermally agitated conduction electrons or the lattice phonons, thereby adding noise to the reflected laser beam. If the reflectance noise can be detected and quantified in a background of other noise in the optical and signal processing systems, the reflectance noise may provide a noncontact measurement of the absolute surface temperature and may be independent of the surface's emissivity. Author

N90-17900*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

NON-CONTACT TEMPERATURE MEASUREMENTS IN SUPPORT OF MICROGRAVITY COMBUSTION EXPERIMENTS **c29**

Paul S. Greenberg *In* JPL, Proceedings of the Second Noncontact Temperature Measurement Workshop 1 Jun. 1989 p 50-59 (For primary document see N90-17894 10-31)
Avail: NTIS HC A16/MF A03 CSCL 22A

Recent conceptual advances in the understanding of combustion science fundamentals in the context of microgravity processes and phenomenology have resulted in an increased demand for diagnostic systems of greater sophistication. Owing primarily to the severe operational constraints that accompany the space flight environment, measurement systems to date remain fairly primative in nature. Qualitative pictures provided by photographic recording media comprise the majority of the existing data, the remainder consisting of the output of conventional transducers, such as thermocouples, hot wires, and pressure transducers. The absence of the rather strong influence of buoyant convection renders microgravity combustion phenomena more fragile than their 1-G counterparts. The emphasis was placed on nonperturbing optical diagnostics. Other factors such as limited supplies of expendable reactants, and periods of microgravity time of sufficient duration, coupled with more fundamental questions regarding inherent length and time scales and reproducibility have favored multipoint or multidimensional techniques. While the development of optical diagnostics for application to combustion science is an extremely active area at present, the peculiarities of space flight hardware severely restrict the feasibility of implementing the majority of techniques which are being utilized in terrestrial applications. The additional requirements for system reliability and operational simplicity have tended to promote somewhat less commonly emphasized techniques such as refractive index mapping and molecular Rayleigh scattering, which are briefly discussed. Author

N90-17901*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

SOLID STATE LASERS FOR USE IN NON-CONTACT TEMPERATURE MEASUREMENTS **c36**

A. M. Buoncristiani *In* JPL, Proceedings of the Second Noncontact Temperature Measurement Workshop 1 Jun. 1989 p 60-69 (For primary document see N90-17894 10-31)
Avail: NTIS HC A16/MF A03 CSCL 20E

The last decade has seen a series of dramatic developments in solid state laser technology. Prominent among these has been the emergence of high power semiconductor laser diode arrays and a deepening understanding of the dynamics of solid state lasers. Taken in tandem these two developments enable the design of laser diode pumped solid state lasers. Pumping solid state lasers with semiconductor diodes relieves the need for cumbersome and inefficient flashlamps and results in an efficient and stable laser with the compactness and reliability. It provides a laser source that can be reliably used in space. These new coherent sources are incorporated into the non-contact measurement of temperature. The primary focus is the development and characterization of new optical materials for use in active remote sensors of the atmosphere. In the course of this effort several new materials and new concepts were studied which can be used for other sensor applications. The general approach to the problem of new non-contact temperature measurements has had two components. The first component centers on passive sensors using optical fibers; an optical fiber temperature sensor for the drop tube was designed and tested at the Marshall Space Flight Center. Work on this problem has given insight into the use of optical fibers, especially new IR fibers, in thermal metrology. The second component of the effort is to utilize the experience gained in the study of passive sensors to examine new active sensor concepts. By active sensor are defined as a sensing device or mechanism which is interrogated in some way be radiation, usually from a laser. The status of solid state lasers as sources for active non-contact temperature sensors are summarized. Some specific electro-optic techniques

are described which are applicable to the sensor problems at hand. Work on some of these ideas is in progress while other concepts are still being worked out. Author

N90-17902*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
SIGNAL PROCESSING APPLIED TO PHOTOTHERMAL TECHNIQUES FOR MATERIALS CHARACTERIZATION **c32**
Abstract Only
James A. Rooney *In its* Proceedings of the Second Noncontact Temperature Measurement Workshop 1 Jun. 1989 p 70 (For primary document see N90-17894 10-31)
Avail: NTIS HC A16/MF A03 CSCL 17B

There is a need to make noncontact measurements of material characteristics in the microgravity environment. Photothermal and photoacoustics techniques offer one approach for attaining this capability since lasers can be used to generate the required thermal or acoustic signals. The perturbations in the materials that can be used for characterization can be detected by optical reflectance, infrared detection or laser detection of photoacoustics. However, some of these laser techniques have disadvantages of either high energy pulsed excitation or low signal-to-noise ratio. Alternative signal processing techniques that have been developed can be applied to photothermal or photoacoustic instrumentation. One fully coherent spread spectrum signal processing technique is called time delay spectrometry (TDS). With TDS the system is excited using a combined frequency-time domain by employing a linear frequency sweep excitation function. The processed received signal can provide either frequency, phase or improved time resolution. This signal processing technique was shown to outperform other time selective techniques with respect to noise rejection and was recently applied to photothermal instrumentation. The technique yields the mathematical equivalent of pulses yet the input irradiances are orders of magnitude less than pulses with the concomitant reduction in perturbation of the sample and can increase the capability of photothermal methods for materials characterization. Author

N90-17903*# National Bureau of Standards, Gaithersburg, MD. Radiometric Physics Div.
RADIATION THERMOMETRY AT NIST: AN UPDATE OF SERVICES AND RESEARCH ACTIVITIES **c35**
G. Barry Hillard *In* JPL, Proceedings of the Second Noncontact Temperature Measurement Workshop 1 Jun. 1989 p 71-79 (For primary document see N90-17894 10-31)
Avail: NTIS HC A16/MF A03 CSCL 14B

An overview of activities at the National Institute of Standards and Terminology (NIST) in radiation thermometry and related temperature scale research is presented. An expansion of calibration services for pyrometers will be described as well as efforts to develop calibration services for blackbody simulators. Research relevant to the realization of the new international temperature scale (ITS 90) will be discussed. Author

N90-17904*# Honeyhill Technical Co., Norwalk, CT.
INFRARED THERMAL IMAGING FIGURES OF MERIT **c35**
Herbert Kaplan *In* JPL, Proceedings of the Second Noncontact Temperature Measurement Workshop 1 Jun. 1989 p 80-89 (For primary document see N90-17894 10-31)
Avail: NTIS HC A16/MF A03 CSCL 14B

Commercially available types of infrared thermal imaging instruments, both viewers (qualitative) and imagers (quantitative) are discussed. The various scanning methods by which thermal images (thermograms) are generated will be reviewed. The performance parameters (figures of merit) that define the quality of performance of infrared radiation thermometers will be introduced. A discussion of how these parameters are extended and adapted to define the performance of thermal imaging instruments will be provided. Finally, the significance of each of the key performance parameters of thermal imaging instruments will be reviewed and procedures currently used for testing to verify performance will be outlined. Author

N90-17905*# Physical Sciences, Inc., Andover, MA.
A MULTICOLOR IMAGING PYROMETER **c35**
Michael B. Frish and Jonathan H. Frank *In* JPL, Proceedings of the Second Noncontact Temperature Measurement Workshop 1 Jun. 1989 p 90-97 (For primary document see N90-17894 10-31)
Avail: NTIS HC A16/MF A03 CSCL 14B

A multicolor imaging pyrometer was designed for accurately and precisely measuring the temperature distribution histories of small moving samples. The device projects six different color images of the sample onto a single charge coupled device array that provides an RS-170 video signal to a computerized frame grabber. The computer automatically selects which one of the six images provides useful data, and converts that information to a temperature map. By measuring the temperature of molten aluminum heated in a kiln, a breadboard version of the device was shown to provide high accuracy in difficult measurement situations. It is expected that this pyrometer will ultimately find application in measuring the temperature of materials undergoing radiant heating in a microgravity acoustic levitation furnace. Author

N90-17906*# Wyman-Gordon Co., North Grafton, MA.
NON-CONTACT TRUE TEMPERATURE MEASUREMENTS IN THE MICROGRAVITY ENVIRONMENT **c29**
Mansoor A. Khan, Charly Allemand, and Thomas W. Eagar (Massachusetts Inst. of Tech., Cambridge.) *In* JPL, Proceedings of the Second Noncontact Temperature Measurement Workshop 1 Jun. 1989 p 98-109 (For primary document see N90-17894 10-31)
Avail: NTIS HC A16/MF A03 CSCL 22A

The theory developed is shown to be capable of calculating true temperature of any material from radiance measurements at a number of different wavelengths. This theory was also shown to be capable of predicting the uncertainty in these calculated temperatures. An additional advantage of these techniques is that they can estimate the emissivity of the target simultaneously with the temperature. This aspect can prove to be very important when a fast method of generating reflectivity vs. wavelength or emissivity vs. wavelength data is required. Experiments performed on various materials over a range of temperatures and experimental conditions were used to verify the accuracy of this theory. Author

N90-17907*# Intersonics, Inc., Northbrook, IL.
SPECTRAL EMISSIVITIES AND OPTICAL CONSTANTS OF ELECTROMAGNETICALLY LEVITATED LIQUID METALS AS FUNCTIONS OF TEMPERATURE AND WAVELENGTH **c35**
S. Krishnan, R. H. Hauge, and J. L. Margrave (Rice Univ., Houston, TX.) *In* JPL, Proceedings of the Second Noncontact Temperature Measurement Workshop 1 Jun. 1989 p 110-140 (For primary document see N90-17894 10-31)
Avail: NTIS HC A16/MF A03 CSCL 14B

The development of a noncontact temperature measurement device utilizing rotating analyzer ellipsometry is described. The technique circumvents the necessity of spectral emissivity estimation by direct measurement concomittant with radiance brightness. Using this approach, the optical properties of electromagnetically levitated liquid metals Cu, Ag, Au, Ni, Pd, Pt, and Zr were measured in situ at four wavelengths and up to 600 K superheat in the liquid. The data suggest an increase in the emissivity of the liquid compared with the incandescent solid. The data also show moderate temperature dependence of the spectral emissivity. A few measurements of the optical properties of undercooled liquid metals were also conducted. The data for both solids and liquids show excellent agreement with available values in the literature for the spectral emissivities as well as the optical constants. Author

N90-17908*# Jet Propulsion Lab., California Inst. of Tech., Pasadena. Applied Sciences and Microgravity.
A POTENTIAL NUCLEAR MAGNETIC RESONANCE IMAGING APPROACH FOR NONCONTACT TEMPERATURE MEASUREMENT **c72**

Stanley L. Manatt *In its* Proceedings of the Second Noncontact Temperature Measurement Workshop 1 Jun. 1989 p 141-149 (For primary document see N90-17894 10-31)
Avail: NTIS HC A16/MF A03 CSCL 20H

It is proposed that in a nuclear magnetic resonance (NMR) imaging experiment that it should be possible to measure temperature through an extended volume. The basis for such a measurement would depend upon sensing a temperature dependent on NMR parameter in an inert, volatile molecule (or fluid) filling the volume of interest. Exploratory work suggest that one suitable candidate for such a purpose might be CH3Cl. Possible parameters, other inert gases and feasible measurement schemes that might provide such temperature measurement are discussed. Author

N90-17909*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
IR OPTICAL FIBER-BASED NONCONTACT PYROMETER FOR DROP TUBE INSTRUMENTATION **c35**
R. G. May, S. Moneyhun, W. Saleh, S. Sudeora, R. O. Claus (Virginia Polytechnic Inst. and State Univ., Blacksburg.), and A. M. Buoncristiani *In* JPL, Proceedings of the Second Noncontact Temperature Measurement Workshop 1 Jun. 1989 p 150-157 (For primary document see N90-17894 10-31)
Avail: NTIS HC A16/MF A03 CSCL 14B

The design of a two color pyrometer with infrared optical fiber bundles for collection of the infrared radiation is described. The pyrometer design is engineered to facilitate its use for measurement of the temperature of small, falling samples in a microgravity materials processing experiment using a 100 meter long drop tube. Because the samples are small and move rapidly through the field of view of the pyrometer, the optical power budget of the detection system is severly limited. Strategies for overcoming this limitation are discussed. Author

N90-17910*# Massachusetts Inst. of Tech., Cambridge.
USE OF ANOMOLOUS THERMAL IMAGING EFFECTS FOR MULTI-MODE SYSTEMS CONTROL DURING CRYSTAL GROWTH **c76**
Michael J. Wargo *In* JPL, Proceedings of the Second Noncontact Temperature Measurement Workshop 1 Jun. 1989 p 158-167 (For primary document see N90-17894 10-31)
Avail: NTIS HC A16/MF A03 CSCL 20L

Real time image processing techniques, combined with multitasking computational capabilities are used to establish thermal imaging as a multimode sensor for systems control during crystal growth. Whereas certain regions of the high temperature scene are presently unusable for quantative determination of temperature, the anomalous information thus obtained is found to serve as a potentially low noise source of other important systems control output. Using this approach, the light emission/reflection characteristics of the crystal, meniscus and melt system are used to infer the crystal diameter and a linear regression algorithm is employed to determine the local diameter trend. This data is utilized as input for closed loop control of crystal shape. No performance penalty in thermal imaging speed is paid for this added functionality. Approach to secondary (diameter) sensor design and systems control structure is discussed. Preliminary experimental results are presented. Author

N90-17911*# North Carolina State Univ., Raleigh. Dept. of Materials Science and Engineering
COMMENTS ON CONTAINERLESS BULK CRYSTAL GROWTH AND EPITAXY IN SPACE AND ON THEIR IMPLICATIONS REGARDING NON-CONTACT TEMPERATURE MEASUREMENTS **c76**
Klaus J. Bachmann *In* JPL, Proceedings of the Second Noncontact Temperature Measurement Workshop 1 Jun. 1989 p 171-182 (For primary document see N90-17894 10-31)
Avail: NTIS HC A16/MF A03 CSCL 20L

Containerless methods are sought for bulk crystal growth and epitaxy which thus far are a less visible component of materials science in space efforts. In the opinion of the author, this is an anomaly which ought to be corrected, because container interactions are a major problem in earth bound materials processing, including crystal growth, and can be avoided or at least significantly reduced in space. The space environment is unique in solving some of these problems, e.g., memory effects in the integration of different classes of materials in high resolution multilayer heterostructures by molecular beam epitaxy or organometallic molecular beam epitaxy. Spectroscopic method of noncontact temperature measurements exist that could be developed in this context. The error in the absolute temperature measurement achieved by these techniques decreases with decreasing substrate temperature and supplements pyrometric measurements that are better suited for high temperature measurements. Author

N90-17912*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
NON-CONTACT TEMPERATURE MEASUREMENT OF A FALLING DROP **c29**
William Hofmeister, R. J. Bayuzick (Vanderbilt Univ., Nashville, TN.), and M. B. Robinson *In* JPL, Proceedings of the Second Noncontact Temperature Measurement Workshop 1 Jun. 1989 p 183-202 (For primary document see N90-17894 10-31)
Avail: NTIS HC A16/MF A03 CSCL 22A

The 105 meter drop tube at NASA-Marshall has been used in a number of experiments to determine the effects of containerless, microgravity processing on the undercooling and solidification behavior of metals and alloys. These experiments have been limited, however, because direct temperature measurement of the falling drops has not been available. Undercooling and nucleation temperatures are calculated from thermophysical properties based on droplet cooling models. In most cases these properties are not well known, particularly in the undercooled state. This results in a large amount of uncertainty in the determination of nucleation temperatures. If temperature measurement can be accomplished then the thermal history of the drops could be well documented. This would lead to a better understanding of the thermophysical and thermal radiative properties of undercooled melts. An effort to measure the temperature of a falling drop is under way. The technique uses two color pyrometry and high speed data acquisition. The approach is presented along with some preliminary data from drop tube experiments. The results from droplet cooling models is compared with noncontact temperature measurements. Author

N90-17913*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
POLYMERIC MATERIALS SCIENCE IN THE MICROGRAVITY ENVIRONMENT **c29**
Daniel R. Coulter *In its* Proceedings of the Second Noncontact Temperature Measurement Workshop 1 Jun. 1989 p 203-209 (For primary document see N90-17894 10-31)
Avail: NTIS HC A16/MF A03 CSCL 22A

The microgravity environment presents some interesting possibilities for the study of polymer science. Properties of polymeric materials depend heavily on their processing history and environment. Thus, there seem to be some potentially interesting and useful new materials that could be developed. The requirements for studying polymeric materials are in general much less rigorous than those developed for studying metals, for example. Many of the techniques developed for working with other materials, including heat sources, thermal control hardware and noncontact temperature measurement schemes should meet the needs of the polymer scientist. Author

N90-17914*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
TEMPERATURE CONTROL AND CALIBRATION ISSUES IN THE GROWTH, PROCESSING AND CHARACTERIZATION OF ELECTRONIC MATERIALS **c76**
B. A. Wilson *In its* Proceedings of the Second Noncontact Temperature Measurement Workshop 1 Jun. 1989 p 210-216

(For primary document see N90-17894 10-31)
Avail: NTIS HC A16/MF A03 CSCL 20L

The temperature control and calibration issues encountered in the growth, processing, and characterization of electronic materials are summarized. The primary problem area is identified as temperature control during epitaxial materials growth. While qualitative thermal measurements are feasible and reproducibility is often achievable within a given system, absolute calibration is essentially impossible in many cases, precluding the possibility of portability from one system to another. The procedures utilized for thermal measurements during epitaxial growth are described, and their limitations discussed. Author

N90-17915*# Bell Telephone Labs., Inc., Murray Hill, NJ.
FLUX LATTICE MELTING IN THE HIGH Tc SUPERCONDUCTORS **c76**
D. J. Bishop, P. L. Gammel, and L. F. Schneemeyer *In* JPL, Proceedings of the Second Noncontact Temperature Measurement Workshop 1 Jun. 1989 p 217-219 (For primary document see N90-17894 10-31)
Avail: NTIS HC A16/MF A03 CSCL 20L

One of the important issues for technological application of the high temperature superconductors is their behavior in a magnetic field. A variety of experiments including electrical transport, mechanical oscillators, and magnetic decoration have suggested that these magnetic properties will make applications more difficult than originally anticipated. These experiments and their results are briefly discussed. Author

N90-17916*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
COMBUSTION PROCESS SCIENCE AND TECHNOLOGY Abstract Only **c25**
Robert R. Hale *In its* Proceedings of the Second Noncontact Temperature Measurement Workshop 1 Jun. 1989 p 220 (For primary document see N90-17894 10-31)
Avail: NTIS HC A16/MF A03 CSCL 07D

An important and substantial area of technical work in which noncontact temperature measurement (NCTM) is desired is that involving combustion process research. In the planning for this workshop, it was hoped that W. Serignano would provide a briefing regarding the experimental requirements for thermal measurements to support such research. The particular features of thermal measurement requirements included those describing the timeline for combustion experiments, the requirements for thermal control and diagnostics of temperature and other related thermal measurements and the criticality to the involved science to parametric features of measurement capability including precision, repeatability, stability, and resolution. In addition, it was hoped that definitions could be provided which characterize the needs for concurrent imaging as it relates to science observations during the conduct of experimentation. Author

N90-17917*# Case Western Reserve Univ., Cleveland, OH. Dept. of Chemical Engineering.
ON THE TEMPERATURE OF SURFACES **c70**
J. Adin Mann, Jr. and Robert V. Edwards *In* JPL, Proceedings of the Second Noncontact Temperature Measurement Workshop 1 Jun. 1989 p 221-229 (For primary document see N90-17894 10-31)
Avail: NTIS HC A16/MF A03 CSCL 20C

The concept of the temperature of a surface is introduced from the viewpoint of the physical chemistry of surfaces. The surface, near surface and microlayer regions of the interface are defined. Most methods measure the temperature of the microlayer or at best the near surface region and may err in representing the surface temperature. Methods based on capillary ripples actually measure the surface temperature since surface tension (or surface tension tensor when a monolayer has been spread or absorbed at the interface) is the main restoring force that controls their propagation. Light scattering methods are described for determining the elevation of very small amplitude capillary waves through the computation of various correlation functions from which the surface tension can be estimated. Procedures for estimating the surface temperature are described. Author

N90-17918*# Vanderbilt Univ., Nashville, TN. Center for Microgravity Research and Applications.
NON-CONTACT TEMPERATURE REQUIREMENTS (NCTM) FOR DROP AND BUBBLE PHYSICS **c29**
Anthony B. Hmelo and Taylor G. Wang *In* JPL, Proceedings of the Second Noncontact Temperature Measurement Workshop 1 Jun. 1989 p 230-235 (For primary document see N90-17894 10-31)
Avail: NTIS HC A16/MF A03 CSCL 22A

Many of the materials research experiments to be conducted in the Space Processing program require a non-contaminating method of manipulating and controlling weightless molten materials. In these experiments, the melt is positioned and formed within a container without physically contacting the container's wall. An acoustic method, which was developed by Professor Taylor G. Wang before coming to Vanderbilt University from the Jet Propulsion Laboratory, has demonstrated the capability of positioning and manipulating room temperature samples. This was accomplished in an earth-based laboratory with a zero-gravity environment of short duration. However, many important facets of high temperature containerless processing technology have not been established yet, nor can they be established from the room temperature studies, because the details of the interaction between an acoustic field an a molten sample are largely unknown. Drop dynamics, bubble dynamics, coalescence behavior of drops and bubbles, electromagnetic and acoustic levitation methods applied to molten metals, and thermal streaming are among the topics discussed. Author

N90-17919*# Purdue Univ., West Lafayette, IN. Center for Information and Numerical Data Analysis and Synthesis.
MATERIALS PROPERTIES NUMERICAL DATABASE SYSTEM ESTABLISHED AND OPERATIONAL AT CINDAS/PURDUE UNIVERSITY **c82**
C. Y. Ho and H. H. Li *In* JPL, Proceedings of the Second Noncontact Temperature Measurement Workshop 1 Jun. 1989 p 236-250 (For primary document see N90-17894 10-31)
Avail: NTIS HC A16/MF A03 CSCL 05B

A computerized comprehensive numerical database system on the mechanical, thermophysical, electronic, electrical, magnetic, optical, and other properties of various types of technologically important materials such as metals, alloys, composites, dielectrics, polymers, and ceramics has been established and operational at the Center for Information and Numerical Data Analysis and Synthesis (CINDAS) of Purdue University. This is an on-line, interactive, menu-driven, user-friendly database system. Users can easily search, retrieve, and manipulate the data from the database system without learning special query language, special commands, standardized names of materials, properties, variables, etc. It enables both the direct mode of search/retrieval of data for specified materials, properties, independent variables, etc., and the inverted mode of search/retrieval of candidate materials that meet a set of specified requirements (which is the computer-aided materials selection). It enables also tabular and graphical displays and on-line data manipulations such as units conversion, variables transformation, statistical analysis, etc., of the retrieved data. The development, content, accessibility, etc., of the database system are presented and discussed. Author

N90-17920*# Honeyhill Technical Co., Norwalk, CT.
AN UPDATE OF COMMERCIAL INFRARED SENSING AND IMAGING INSTRUMENTS **c35**
Herbert Kaplan *In* JPL, Proceedings of the Second Noncontact Temperature Measurement Workshop 1 Jun. 1989 p 253-270 (For primary document see N90-17894 10-31)
Avail: NTIS HC A16/MF A03 CSCL 14B

A classification of infrared sensing instruments by type and application, listing commercially available instruments, from single point thermal probes to on-line control sensors, to high speed,

high resolution imaging systems is given. A review of performance specifications follows, along with a discussion of typical thermographic display approaches utilized by various imager manufacturers. An update report on new instruments, new display techniques and newly introduced features of existing instruments is given. Author

N90-17921*# Barnes Engineering Co., Stamford, CT.
A SPACE QUALIFIED THERMAL IMAGING SYSTEM USING A Pt Si DETECTOR ARRAY c35
Robert W. Astheimer *In* JPL, Proceedings of the Second Noncontact Temperature Measurement Workshop 1 Jun. 1989 p 271-283 (For primary document see N90-17894 10-31)
Avail: NTIS HC A16/MF A03 CSCL 14B

EDO Corporation, Barnes Engineering Division designed and constructed a high resolution thermal imaging system on contract to Lockheed for use in the SDI Star Lab. This employs a Pt Si CCD array which is sensitive in the spectral range of 3 to 5 microns. Star Lab will be flown in the Shuttle bay and consists basically of a large, reflecting, tracking telescope with associated sensors and electronics. The thermal imaging system is designed to operate in the focal plane of this telescope. The configuration of the system is illustrated. The telescope provides a collimated beam output which is focussed onto the detector array by a silicon objective lens. The detector array subtends a field of view of 1.6 degrees x 1.22 degrees. A beam switching mirror permits bypassing the large telescope to give a field of 4 degrees x 3 degrees. Two 8 position filter wheels are provided, and background radiation is minimized by Narcissus mirrors. The detector is cooled with a Joule-Thompson cryostat fed from a high pressure supply tank. This was selected instead of a more convenient closed-cycle system because of concern with vibration. The latter may couple into the extremely critical Starlab tracking telescope. The electronics produce a digitized video signal for recording. Offset and responsivity correction factors are stored for all pixels and these corrections are made to the digitized output in real time. Author

N90-17922*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
DEVELOPMENT OF AN INFRARED IMAGING SYSTEM FOR THE SURFACE TENSION DRIVEN CONVECTION EXPERIMENT c35
Alexander D. Pline *In* JPL, Proceedings of the Second Noncontact Temperature Measurement Workshop 1 Jun. 1989 p 284-293 Previously announced as N89-17211 (For primary document see N90-17894 10-31)
Avail: NTIS HC A16/MF A03 CSCL 14B

An infrared imaging system is used to quantify the imposed surface temperature distribution along a liquid/gas free surface in support of the Surface Tension Driven Convection Experiment, a planned Space Transportation System flight experiment. For ground-based work a commercially available instrument was used to determine the feasibility of using this type of imaging system for this experiment. The ground-based work was used as a baseline for compiling specifications for a flight qualified imager to be designed, fabricated, tested and qualified for flight. The requirements and the specifications for the flight model are given along with the reasons for departures from the ground-based equipment. The flight qualification requirements discussed are a representative sample of the necessary procedures which must be followed to flight qualify diagnostic equipment for use aboard the STS. The potential problems and concerns associated with operating an imaging system on orbit are also discussed. Author

N90-17923*# Honeyhill Technical Co., Norwalk, CT.
NCTM WORKSHOP SPLINTER SESSION, IR THERMAL MEASUREMENT INSTRUMENTS Abstract Only c35
Herbert Kaplan *In* JPL, Proceedings of the Second Noncontact Temperature Measurement Workshop 1 Jun. 1989 p 297-298 (For primary document see N90-17894 10-31)
Avail: NTIS HC A16/MF A03 CSCL 14B

The splinter session dealing with commercial industrial thermal measurement state-of-the-hardware had a total attendance of 15. Two papers were presented in the splinter session as follows: (1) Development of an Infrared Imaging System for the Surface Tension Driven Convection Experiment, Alexander D. Pline, NASA LeRC; (2) A Space-qualified PtSi Thermal Imaging System, Robert W. Astheimer, Barnes Engineering Div., EDO Corp. In addition a brief description of SPRITE detector technology was presented by Richard F. Leftwich of Magnovox. As anticipated, the discussions were concerned mainly with thermal imaging figures of merit rather than those for point measurement instruments. The need for uniform guidelines whereby infrared thermal imaging instruments could be specified and evaluated was identified as most important, particularly where temperature measurements are required. Presently there are differences in the way different manufacturers present significant performance parameters in their instrument data sheets. Furthermore, the prospective user has difficulty relating these parameters to actual measurement needs, and procedures by which performance can be verified are poorly defined. The current availability of powerful thermal imaging diagnostic software was discussed. Author

N90-17924*# Oak Ridge National Lab., TN.
DYNAMIC RESPONSE FOR THERMAL CONTROL AND MEASUREMENT AND FAST RADIATION THERMOMETRY c35
R. L. Shepard and A. Cezairliyan (National Bureau of Standards, Gaithersburg, MD.) *In* JPL, Proceedings of the Second Noncontact Temperature Measurement Workshop 1 Jun. 1989 p 299-302 (For primary document see N90-17894 10-31)
Avail: NTIS HC A16/MF A03 CSCL 14B

A preliminary evaluation was made by ORNL of a two-color ratio pyrometer (TCRP) for temperature control in the Modular Electromagnetic Levitation (MEL) experiment. A discussion was presented by Eric Spjut at the 1987 NASA Non-Contact Temperature Measurement Workshop (NASA Conf. Publ. 2503, pp. 182-213) in which he described the non-linear characteristics of the time response of TCPs. Researchers replicated his model and results and note that the non-linear response behavior is minimized for small temperature steps at high temperatures. They then used the predicted response in a model for a proportional or integral feedback controller and predicted the control characteristics for heating and cooling a 5-mm diameter sphere of niobium at high (1500 to 2750 K) temperatures. The analysis shows that for a slow (25-ms) time response for a commercial RCRP, overshoots of several hundred kelvins will result from a 100-K decrease in the setpoint, and temperature tracking errors of 14 to 45 K will occur for control temperature ramps of 1000K/s. For a fast (greater than 0.1 ms) time response, the overshoot and ramp response errors are largely eliminated. Author

N90-17925*# Purdue Univ., West Lafayette, IN. School of Mechanical Engineering.
MATERIALS THERMAL AND THERMORADIATIVE PROPERTIES/CHARACTERIZATION TECHNOLOGY c25
D. P. DeWitt and C. Y. Ho *In* JPL, Proceedings of the Second Noncontact Temperature Measurement Workshop 1 Jun. 1989 p 303-316 (For primary document see N90-17894 10-31)
Avail: NTIS HC A16/MF A03 CSCL 07D

Reliable properties data on well characterized materials are necessary for design of experiments and interpretation of experimental results. The activities of CINDAS to provide data bases and predict properties are discussed. An understanding of emissivity behavior is important in order to select appropriate methods for non-contact temperature determination. Related technical issues are identified and recommendations are offered. Author

N90-17926*# Massachusetts Inst. of Tech., Cambridge.
REPORT ON THE MULTICOLOR PYROMETRY SESSION AT THE SECOND NASA NON-CONTACT TEMPERATURE-MEASUREMENT WORKSHOP Abstract Only c35
R. Erik Spjut *In* JPL, Proceedings of the Second Noncontact

Temperature Measurement Workshop 1 Jun. 1989 p 317-318
(For primary document see N90-17894 10-31)
Avail: NTIS HC A16/MF A03 CSCL 14B

The session met jointly with the other special sessions. Due to time constraints, the concerns of multicolor pyrometry were not addressed in depth. Multicolor pyrometry attempts to determine an object's temperature and emittance as a function of wavelength from simultaneous measurement of the spectral radiance of the object at multiple wavelengths. The main issues are those of the most appropriate model for the wavelength dependence of the emittance, the number of undetermined parameters, and the error in the measured temperature. It has long been known that it is inappropriate to attempt to model the emittance with a functional form that contains as many unknowns as wavelengths. Such attempts will lead to gross errors in the measured temperature. However, more recent work by Hunter and Khan has indicated that emittance can be modeled by a function with many fewer degrees of freedom than sampled wavelengths (e.g., it may be appropriate to use a second order polynomial to fit data from a forty-color pyrometer). In a platform lecture, Khan described algorithms for determination of the parameters by minimization of the errors between the model and the data in a least-squares sense. The first was a linear method and the second was a non-linear method where the emittance could assume any functional form. Both methods were shown to be very sensitive to random noise and non-linearity in the measurement system.
Author

N90-17927# Metalworking Technology, Inc., Johnstown, PA.
HIGH PRESSURE WATERJET CUTTING INDUSTRIAL NEEDS SURVEY Final Report, Oct. 1988 - Sep. 1989
John Klavuhn and Bruce Baker 25 Aug. 1989 43 p
(Contract N00140-88-C-RC21)
(AD-A214952) Avail: NTIS HC A03/MF A01 CSCL 11/6

The results are presented of a survey conducted by personnel of the National Center for Excellence in Metalworking Technology (NCEMT) to assess the industrial needs in high pressure water jet cutting (WJC) technology. Survey forms were mailed to approximately 1400 individuals obtained from three mailing lists. The respondents included approximately 200 individuals associated with a variety of industries: 12 percent were WJC equipment suppliers, 40 percent were WJC users, and 48 percent were neither suppliers nor users. The survey addressed five specific areas of WJC technology: research and development, standards, systems, new products, and training and service. Results show that the need having the highest priority is the establishment of a database on WJC that contains the cutting parameters for a wide range of materials. Associated with this objective is the expressed need for an independent demonstration and test center for testing, data generation and operator training. A further need was found for establishing organized efforts in hardware development and research in mechanisms of cutting.
GRA

N90-17928# Consiglio Nazionale delle Ricerche, Frascati (Italy). Ist. di Fisica dello Spazio Interplanetario.
FLATNESS AND ROUGHNESS METROLOGICAL TESTS ON THE WRA FLIGHT UNIT RECEIVER BOX AND ACPB CANISTER OF THE RETE EXPERIMENT [PROVE METROLOGICHE DI PLANARITA' E RUGOSITA' ESEGUITE SULLE UNITA' DI VOLO WRA RECEIVER BOX E ACBP CANISTER DELL'ESPERIMENTO RETE]
Paolo Baldetti Dec. 1988 30 p In ITALIAN Original contains color illustrations
(IFSI-88-20; ETN-90-96159) Avail: NTIS HC A03/MF A01

Metrological measurements of the two spacecraft components were carried out in a test room at 17 C using a reference polished stone plane and a Surtronic 3 P profilometer. It is shown that roughness is strongly dependent on the materials used, being considerably larger for composite materials.
ESA

N90-17929*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
A NEW APPROACH TO ACTIVE VIBRATION ISOLATION FOR MICROGRAVITY SPACE EXPERIMENTS
Alok Sinha, Chikuan K. Kao (Pennsylvania State Univ., University Park.), and Carlos M. Grodsinsky Feb. 1990 11 p
(Grant NAG3-949)
(NASA-TM-102470; E-5257; NAS 1.15:102470) Avail: NTIS HC A03/MF A01 CSCL 13I

A new method was developed to design an active vibration isolation system for microgravity space experiments. This method yields the required controller transfer functions for a specified transmissibility ratio. Hence, it is a straightforward task to guarantee that the desired vibration isolation performance is achieved at each frequency. The theory for such a controller design was presented by considering a single degree of freedom system. In addition, the magnitude of the input required by the new method has been found to be less than that used by a standard phase lead/lag compensator.
Author

N90-17930# Federal Aviation Administration, Atlantic City, NJ. Technical Center.
PRELIMINARY FIRE EXTINGUISHING TESTS WITH HANDHELD BOTTLES: A COMPARISON OF EXTINGUISHING COMPOUNDS
T. M. Guastavino and F. Fann Jan. 1990 30 p
(DOT/FAA/CT-TN89/60) Avail: NTIS HC A03/MF A01

In 1982, the Federal Aviation Administration (FAA) Technical Center completed a test and evaluation project on use of handheld extinguishers in transport category aircraft. Some of the tests involved the comparative effectiveness of handheld extinguishers in a specific fire scenario: a triple non-fireblocked aircraft seat ignited with gasoline. The test work included the identification and quantification of effluent gas species produced by the fire and the extinguishing chemicals. The comparative effectiveness of the extinguishers used in the above tests and some newer systems in two distinct fire tests are described. The first test is the crib test used by Underwriters Laboratory, Inc. to rate handheld estinguishers. The second test is the same seat test used in the earlier work. The tests employed aircraft approved water extinguishers and Halon 1211 extinguishers as benchmarks. New formulations using surfactants and extinguishing powders in aqueous solutions were tested against the benchmark performance levels. In these tests, certain new solutions were able to meet or exceed the performance of the benchmark agents.
Author

N90-17931# Aerojet TechSystems Co., Sacramento, CA.
INVESTIGATION OF APPLICATIONS OF DIAMOND FILM Final Report, Aug. 1988 - May 1989
D. M. Jassowski Nov. 1989 262 p
(Contract F04611-88-C-0074; AF Proj. 3058)
(AD-A216104; AL-TR-89-044) Avail: NTIS HC A12/MF A02 CSCL 21/8

The unique properties of synthetic diamond prepared by chemical vapor deposition suggest potential aerospace applications of interest to the Air Force. The status of the rapidly developing technology of low-pressure diamond film synthesis has been determined by contacts with 76 research groups active in the field. Information on six synthetic techniques and a list of 112 active groups are included. Updated diamond film properties are presented based on the survey, literature data, and the measurements made in this program. Measurements were made of hydrogen diffusion resistance, hardness, thermal shock resistance, rupture strength, and propellant compatibility. A comprehensive screen of 200 potential Air Force applications is presented. These were reduced to a 4 high-value applications: bearing surfaces, barriers for hydrogen diffusion, barriers for propellant corrosion protection, and thermal protection for surfaces with localized high heat flux. Initial reports of unusually high tensile strength for diamond films cannot be supported by detailed analysis of test data, eliminating some structural applications. Technology development plans are presented for obtaining better properties

data for demonstrating the application of diamond films to bearings. GRA

32 COMMUNICATIONS AND RADAR

Includes radar; land and global communications; communications theory; and optical communications.

For related information see also *04 Aircraft Communications and Navigation* and *17 Space Communications, Spacecraft Communications, Command and Tracking.* For search and rescue see *03 Air Transportation and Safety,* and *16 Space Transportation.*

N90-17932# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Electromagnetic Wave Propagation Panel.

MODERN ANTENNA DESIGN USING COMPUTERS AND MEASUREMENT: APPLICATION TO ANTENNA PROBLEMS OF MILITARY INTEREST

Sep. 1989 224 p Lectures held in Ankara, Turkey, 19-20 Oct. 1989, in Lisbon, Portugal, 23-24 Oct. 1989, and in London, England, 26-27 Oct. 1989

(AGARD-LS-165; ISBN-92-835-0526-3) Copyright Avail: NTIS HC A10/MF A02; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

The working environment in which an antenna is installed may substantially modify such antenna parameters as radiation efficiency, impedance, bandwidth, power handling capacity or pattern. The need for more accurate antenna design, combined with the continuing growth of computational techniques, are complementing the more traditional approaches of measurement and analysis to vastly broaden the breadth and depth of problems that are now quantifiable. Computers are being used not only for numerical modeling/simulation, but also for measurement, data acquisition, and subsequent transformation of data. The newly available computational techniques is changing the way one thinks about, formulates, solves, and interprets problems. For individual titles, see N90-17933 through N90-17941.

N90-17933# General Research Corp., Santa Barbara, CA.

A SELECTIVE SURVEY OF COMPUTATIONAL ELECTROMAGNETICS FOR ANTENNA APPLICATIONS

E. K. Miller *In* AGARD, Modern Antenna Design Using Computers and Measurement: Application to Antenna Problems of Military Interest Sep. 1989 29 p (For primary document see N90-17932 10-32)

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The continuing growth of computing resources is changing how one thinks about, formulates, solves, and interprets problems. In electromagnetics as elsewhere, computational techniques are complementing the more traditional approaches of measurement and analysis to vastly broaden the breadth and depth of problems that are now quantifiable. An attempt is made to place into perspective some of the tools used in computational electromagnetics with respect to the different kinds of approaches that may be used and their computer-resource requirements, paying particular attention to numerical models based on integral and differential equations. After a brief background discussion, some of the analytical and numerical issues involved in developing a computer model are reviewed. Some practical considerations are included from the viewpoint of computer-resource requirements, followed by a discussion of some ways by which computer time might be reduced. Validation and error checking are briefly examined. Emphasis throughout is on review and summarization rather than detailed exposition. Author

N90-17934# Lawrence Livermore National Lab., CA.

RECENT ADVANCES TO NEC: APPLICATIONS AND VALIDATION

G. J. Burke *In* AGARD, Modern Antenna Design Using Computers and Measurement: Application to Antenna Problems of Military Interest Sep. 1989 25 p Previously announced as N90-11917 (For primary document see N90-17932 10-32)

(Contract W-7405-eng-48)

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Capabilities of the antenna modeling code Numerical Electromagnetics Code (NEC) are reviewed and results are presented to illustrate typical applications. Recent developments are discussed that will improve accuracy in modeling electrically small antennas, stepped-radius wires and junctions of tightly coupled wires, and also a new capability for modeling insulated wires in air or earth is described. These advances will be included in a future release of NEC, while for now the results serve to illustrate limitations of the present code. NEC results are compared with independent analytical and numerical solutions and measurements to validate the model for wires near ground and for insulated wires. Author

N90-17935# General Research Corp., Santa Barbara, CA.

SOME APPLICATIONS OF MODEL-BASED PARAMETER ESTIMATION IN COMPUTATIONAL ELECTROMAGNETICS

E. K. Miller and G. J. Burke (Lawrence Livermore National Lab., CA.) *In* AGARD, Modern Antenna Design Using Computers and Measurement: Application to Antenna Problems of Military Interest Sep. 1989 26 p (For primary document see N90-17932 10-32)

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All of electromagnetics, whether measurement analysis, or computation, may be regarded as activities of information acquisition, processing, and presentation. It is relevant to mention the information-intensive nature of electromagnetics because this property can provide a useful, unifying perspective from which might be developed efficiency improvements in these various areas. If, for example, redundant information can be reduced or avoided in numerical calculations, the result should be a possibly substantial decrease in the amount of computer time that is needed for computer modeling. The use of a generalized signal-processing approach called model-based parameter estimation (MBPE) for making various improvements in either the efficiency of electromagnetic computer modeling or the efficiency of representing electromagnetic observables is considered. One is to increase the efficiency of the basic model computation itself, a typical example being that of replacing the rigorous Green's function for the antenna-interface problem by a simpler, more easily computable, approximation. Another is to make more efficient use of the results that are computed, for example, by reducing the number of samples needed to construct a transfer function over some frequency band. A third arises because the electromagnetic fields/sources in various transformed-pair domains, such as exhibited by the far fields and locations of a linear-source array, are described by exponential and pole series from which physically relevant parameters can be extracted, which are useful for such purposes as data compression and physical interpretation. The discussion deals primarily with MBPE based on exponential- and poles-series models which yield generalized waveform- and spectral-domain response functions of various transform-pair variables. It is demonstrated how sampling such observables in terms of the appropriate variable or derivatives thereof leads to a data matrix from which the model parameters can be computed. Various kinds of data and models are used to illustrate the breadth of potential applications, with an emphasis on estimating frequency responses from frequency-sampled data. Some concluding remarks are addressed to use of MBPE for the Green's-function application. Author

N90-17936# Concordia Univ., Montreal (Quebec). EMC Lab.

MEASUREMENT AND COMPUTER SIMULATION OF ANTENNAS ON SHIPS AND AIRCRAFT FOR RESULTS OF OPERATIONAL RELIABILITY

Stanley J. Kubina *In* AGARD, Modern Antenna Design Using Computers and Measurement: Application to Antenna Problems of Military Interest Sep. 1989 28 p Sponsored in part by Defence Research Establishment, Ottawa, and by National Sciences and Engineering Research Council (For primary document see N90-17932 10-32)
Copyright Avail: NTIS HC A10/MF A02; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

The review of the status of computational electromagnetics by Miller and the exposition by Burke of the developments in one of the more important computer codes in the application of the electric field integral equation method, the Numerical Electromagnetic Code (NEC), coupled with Molinet's summary of progress in techniques based on the Geometrical Theory of Diffraction (GTD), provide a clear perspective on the maturity of the modern discipline of computational electromagnetics and its potential. Audone's exposition of the application to the computation of Radar Scattering Cross-section (RCS) is an indication of the breadth of practical applications and his exploitation of modern near-field measurement techniques reminds one of progress in the measurement discipline which is essential to the validation or calibration of computational modeling methodology when applied to complex structures such as aircraft and ships. The latter monograph also presents some comparison results with computational models. Some of the results presented for scale model and flight measurements show some serious disagreements in the lobe structure which would require some detailed examination. This also applies to the radiation patterns obtained by flight measurement compared with those obtained using wire-grid models and integral equation modeling methods. In the examples which follow, an attempt is made to match measurements results completely over the entire 2 to 30 MHz HF range for antennas on a large patrol aircraft. The problem of validating computer models of HF antennas on a helicopter and using computer models to generate radiation pattern information which cannot be obtained by measurements are discussed. The use of NEC computer models to analyze top-side ship configurations where measurement results are not available and only self-validation measures are available or at best comparisons with an alternate GTD computer modeling technique is also discussed. Author

N90-17937# Communications Research Centre, Ottawa (Ontario).
HF WIRE ANTENNAS OVER REAL GROUND: COMPUTER SIMULATION AND MEASUREMENT
John S. Belrose, G. M. Royer, and L. E. Petrie (Petrie Telecommunications, Ottawa, Ontario) *In* AGARD, Modern Antenna Design Using Computers and Measurements: Application to Antenna Problems of Military Interest Sep. 1989 30 p (For primary document see N90-17932 10-32)
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The considerable combined experience with numerical and experimental modeling, with fabricating, with measuring performance of and with using practical HF antennas for the low HF band (2 to 8 MHz) is examined. The antenna poses a particularly difficult problem for this frequency band, particularly if a broad-band antenna is wanted for frequency agile systems, because of the four-to-one change in wavelength over the band. A further complication is that as the frequency is reduced so is the electrical height of the antenna above the ground, and since the ground is an imperfect conductor, the finite conductivity of the ground introduces loss of gain, and detuning. There is great concern with antennas at low (electrical) heights, even with antennas very near to or actually lying on the ground. Antennas lying on or near the ground are of particular interest for military tactical communicators, since low profile antenna systems that require no support mast or masts are operationally and logistically an advantage for use in a tactical environment. HF radio operators in the Canadian north have frequently reported success with using HF dipoles lying on the ground. The reason that antennas perform at all under the circumstances is because of the very low ground conductivities found in the Canadian north. It is shown what gain to expect under such circumstances. The comparison between computer simulation with measurement is emphasized, and with the application of computers for both numerical modeling, measurement, and data analysis and presentation. Author

N90-17938# Hochschule der Bundeswehr, Munich (Germany, F.R.).
ANTENNAS ON LAND VEHICLES FOR IMPROVED COMMUNICATIONS
H. K. Lindenmeier *In* AGARD, Modern Antenna Design Using Computers and Measurement: Application to Antenna Problems of Military Interest Sep. 1989 19 p (For primary document see N90-17932 10-32)
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In the meter wave region the time and space dependent superposition of a multitude of waves with great time delay leads to receiving distortions at the location of reception especially in a driven car. This multipath reception, which reduces the quality of FM-reception by noise or by AF-distortions, was investigated in theory and computer-aided measurements were made by means of test transmissions from a broadcasting station to evaluate the statistical distribution of the sets of superimposed time delayed waves causing multipath distortion in the receiver. These results are discussed. By means of a specially developed measuring device receiving distortions were evaluated statistically for several different types of car antennas under various measuring conditions. For application in an antenna-diversity system a distortion detector was developed which by means of signal processing indicates not only multipath distortions as a result of great time delays between superimposed waves but also indicates noise interference as well as co-channel interference and nonlinear distortions as a result of large signal interference. Main feature of this detector is its extremely short detection time of 25 microseconds which is limited to the group delay time of the if-filters of the receiver. On the basis of this distortion detector in combination with a logic processor the performance of antenna-diversity is investigated as a function of the number of implemented antennas. The results show that the improvement factor increases considerably by the number of antennas applied. Author

N90-17939# Societe Mothesim, Le Plessis-Robinson (France).
GTD/UTD: BRIEF HISTORY OF SUCCESSIVE DEVELOPMENT OF THEORY AND RECENT ADVANCES. APPLICATIONS TO ANTENNAS ON SHIPS AND AIRCRAFT
F. A. Molinet *In* AGARD, Modern Antenna Design Using Computers and Measurement: Application to Antenna Problems of Military Interest Sep. 1989 22 p (For primary document see N90-17932 10-32)
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The basic concepts of Geometrical Theory of Diffraction (GTD) and its relation to the wave equation are reviewed in the frame-work of asymptotic expansions which historically formed the basis for further developments and improvements of the theory. Uniform solutions and especially the Uniform Theory of Diffraction (UTD) are introduced and a brief synthesis of successive development of GTD/UTD is presented. Among the subjects which were recently advanced, those which either lead to fundamental improvements of the theory or which have an important impact on its applications to current radiation and scattering problems have been selected and analyzed in more details. A great emphasis is given to the extension of GTD/UTD to metallic bodies with coatings. Finally some general ideas for conceiving a computer program founded on GTD/UTD are presented together with some software packages which were recently developed in France. A few selected applications of these computer programs to predict the EM radiation from antennas on an aircraft or a spacecraft and on a ship are described and illustrated by graphical displays. Author

N90-17940# Aeritalia S.p.A., Caselle Torinese (Italy). Gruppo Sistemi e Teleguidati.
COMPACT RANGES IN ANTENNA AND RCS MEASUREMENTS
B. Audone *In* AGARD, Modern Antenna Design Using Computers and Measurement: Application to Antenna Problems of Military Interest Sep. 1989 16 p (For primary document see N90-17932 10-32)
Copyright Avail: NTIS HC A10/MF A02; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

With the increased complexity and extended frequency range of operation model measurements and far field test ranges are no longer suitable to satisfy the demand of accurate testing. Moreover plane wave test conditions are required for Radar Cross Section (RCS) measurements which represent a key point in stealth technology. Compact ranges represent the best test facilities available presently since they allow for indoor measurements under far field conditions in real time without any calculation effort. Several types of compact ranges are described and compared discussing their relevant advantages with regard to RCS and antenna measurements. In parallel to measuring systems sophisticated computer models were developed with such a high level of accuracy that it is questionable whether experiments give better results than theory. Tests performed on simple structures show the correlation between experimental results and theoretical ones derived on the basis of GTD computer codes. Author

N90-17941# British Aerospace Dynamics Group, Bristol (England). Microwave Antennas.
ANTENNA INSTALLATION ON AIRCRAFT: THEORY AND PRACTICE
T. J. Murphy *In* AGARD, Modern Antenna Design Using Computers and Measurement: Application to Antenna Problems of Military Interest Sep. 1989 8 p (For primary document see N90-17932 10-32)
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The problems to be faced in the integration of an antenna system onto an aircraft are reviewed. The techniques, both mathematical and empirical, used to assess radiation pattern performance are placed in the context of the requirement on the airframe as a system. A systematic approach to the integration task is described which experience has shown to be suited to the overall task. Author

N90-17942# Royal Signals and Radar Establishment, Malvern (England).
CONNECTED DIGIT RECOGNITION IN A MULTILINGUAL ENVIRONMENT
R. K. Moore Feb. 1988 21 p
(AD-A196150; RSRE-Memo-4134) Copyright Avail: NTIS HC A03/MF A01 CSCL 17/2

The several languages and language dialects used by the member nations of NATO generate many questions regarding the use of speech recognition systems for NATO related applications. Two questions which immediately arise are: are speech recognition systems sensitive to the differences between the several languages even though each system may be trained on a specific language of interest, and if an operator of a speech recognition system uses a language other than his/her primary language, is the recognition performance of the system compromised by the use of the secondary language. These and other questions were addressed by conducting a series of speech recognition tests using a multiple language speech database. The connected digit recognition performance is closely examined. Author

N90-17943# Ballistic Research Labs., Aberdeen Proving Ground, MD. System Engineering and Concepts Analysis Div.
PARAMETRIC SPECTRAL ESTIMATION TECHNIQUES FOR COHERENT MILLIMETER-WAVE RADAR
Floyd C. Wofford Nov. 1989 42 p
(AD-A214355; BRL-TR-3062) Avail: NTIS HC A03/MF A01 CSCL 17/9

Reports of research in Millimeter-Wave radar indicate little work was performed in spectral analysis of clutter returns for coherent systems. The advantages of parametric spectral estimation methods make them an excellent choice to perform the spectral analysis. These advantages are detailed. GRA

N90-17944# Hughes Aircraft Co., Fullerton, CA.
ADAPTIVE PROCESSOR EMULATION DEVELOPMENT Final Technical Report, Sep. 1986
A. G. Jaffer, J. M. Ortiz, C. G. Passante, and James H. Sawyers Oct. 1989 112 p
(Contract F30602-86-C-0227; AF Proj. 4506)
(AD-A214392; HAC-FR88-1F-25; RADC-TR-89-186) Avail: NTIS HC A06/MF A01 CSCL 17/9

A comprehensive airborne radar simulation program was developed that emulates the performance of modern Doppler filtering/CFAR techniques operating in a simulated nonstationary airborne clutter environment. Conventional and advanced adaptive Doppler filtering/CFAR techniques are implemented in the software which is created for the VAX 11/780 computer. The adaptive Doppler filtering techniques are based on modern spectral estimation methods: the autocorrelation lags estimate method (ALE); the forward-backward sample matrix inversion method (FBSMI); the maximum entropy method (MEM); the maximum likelihood/maximum entropy method (MLM/MEM); the modified least-squares autoregressive method (MLSA); and the principal eigenvector subspace method (PESM). GRA

N90-17945*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
PROCEEDINGS OF THE THIRTEENTH NASA PROPAGATION EXPERIMENTERS MEETING (NAPEX 13)
Faramaz Davarian, ed. 15 Aug. 1989 242 p Meeting held in San Jose, CA, 29-30 Jun. 1989
(Contract NAS7-918)
(NASA-CR-186062; JPL-Publ-89-26; NAS 1.26:186062) Avail: NTIS HC A11/MF A02 CSCL 17B

The NASA Propagation Experimenters Meeting (NAPEX), supported by the NASA Propagation Program, is convened annually to discuss studies made on radio wave propagation by investigators from domestic and international organizations. The meeting was organized into three technical sessions: the first focused on mobile satellite propagation; the second examined the propagation effects for frequencies above 10 GHz; and the third addressed studies devoted exclusively to the Olympus/Advanced Communications Technology Satellite (ACTS) Program. For individual titles, see N90-17946 through N90-17964.

N90-17946*# Colorado Univ., Boulder. Dept. of Electrical and Computer Engineering.
NASA PROPAGATION INFORMATION CENTER c82
Ernest K. Smith and Warren L. Flock *In* JPL, Proceedings of the 13th NASA Propagation Experimenters Meeting (NAPEX 13) 15 Aug. 1989 p 10-13 (For primary document see N90-17945 10-32)
Avail: NTIS HC A11/MF A02 CSCL 05B

The NASA Propagation Information Center became formally operational in July 1988. It is located in the Department of Electrical and Computer Engineering of the University of Colorado at Boulder. The Center is several things: a communications medium for the propagation with the outside world, a mechanism for internal communication within the program, and an aid to management. Author

N90-17947*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
FIELD MEASUREMENTS IN MSAT-X
Khaled Dessouky and Loretta Ho *In its* Proceedings of the 13th NASA Propagation Experimenters Meeting (NAPEX 13) 15 Aug. 1989 p 18-26 (For primary document see N90-17945

10-32)
Avail: NTIS HC A11/MF A02 CSCL 17B

Results from the most recent MSAT-X field experiments, the Tower-3 Experiment and the JPL/FAA/INMARSAT MARECS-B2 Satellite Experiment, are presented. Results that distinguish the propagation environment of the tower set-up are given and explained. The configuration and flight variables of the aeronautical experiment which used an FAA aircraft and an INMARSAT satellite are described. Results that highlight the disturbances on the aeronautical satellite channel are presented. The roles of satellite-induced signal variations and of multipatch are identified and their impact on the link is discussed. Author

N90-17948*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
CHANNEL SIMULATOR UPGRADE TO USE FIELD PROPAGATION DATA
Jeff B. Berner *In its* Proceedings of the 13th NASA Propagation Experimenters Meeting (NAPEX 13) 15 Aug. 1989 p 27-31 (For primary document see N90-17945 10-32)
Avail: NTIS HC A11/MF A02 CSCL 17B

The JPL Channel Simulator lab was modified to allow full duplex links and to allow the use of field propagation data for link fading. This capability will be used to test equipment for the joint AUSSAT/NASA mobile satellite experiment in July 1989. Author

N90-17949*# Texas Univ., Austin.
THE AUSTRALIAN EXPERIMENT WITH ETS-V
Wolfhard J. Vogel, Julius Goldhirsh (Johns Hopkins Univ., Laurel, MD.), and Yoshihiro Hase *In* JPL, Proceedings of the 13th NASA Propagation Experimenters Meeting (NAPEX 13) 15 Aug. 1989 p 32-41 Sponsored in part by the Science and Technology Agency of Japan (For primary document see N90-17945 10-32)
Avail: NTIS HC A11/MF A02 CSCL 17B

Land-mobile satellite propagation measurements were implemented at L Band (1.5 GHz) in South-Eastern Australia during an 11 day period in October 1988. Transmissions (CW) from both the Japanese ETS-5 and INMARSAT Pacific geostationary satellites were accessed. Previous measurements in this series were performed at both L Band (1.5 GHz) and UHF (870 MHz) in Central Maryland, North-Central Colorado, and the southern United States. The objectives of the Australian campaign were to expand the data base acquired in the U.S. to another continent, to validate a U.S. derived empirical model for estimating the fade distribution, to establish the effects of directive antennas, to assess the isolation between co- and cross-polarized transmissions, to derive estimates of fade as well as non-fade durations, and to evaluate diversity reception. All these objectives were met. Author

N90-17950*# Texas Univ., Austin. Electrical Engineering Research Lab.
LMSS DRIVE SIMULATOR FOR MULTIPATH PROPAGATION
Praveen Vishakantaiah and Wolfhard J. Vogel *In* JPL, Proceedings of the 13th NASA Propagation Experimenters Meeting (NAPEX 13) 15 Aug. 1989 p 42-47 (For primary document see N90-17945 10-32)
Avail: NTIS HC A11/MF A02 CSCL 17B

A three-dimensional drive simulator for the prediction of Land Mobile Satellite Service (LMSS) multipath propagation was developed. It is based on simple physical and geometrical rules and can be used to evaluate effects of scatterer numbers and positions, receiving antenna pattern, and satellite frequency and position. It is shown that scatterers close to the receiver have the most effect and that directive antennas suppress multipath interference. Author

N90-17951*# Ministry of Posts and Telecommunications, Kashima (Japan). Communications Research Lab.
JAPANESE PROPAGATION EXPERIMENTS WITH ETS-5
Tetsushi Ikegami *In* JPL, Proceedings of the 13th NASA Propagation Experimenters Meeting (NAPEX 13) 15 Aug. 1989 p 48-55 (For primary document see N90-17945 10-32)
Avail: NTIS HC A11/MF A02 CSCL 17B

Propagation experiments for maritime, aeronautical, and land mobile satellite communications were performed using Engineering Test Satellite-Five (ETS-5). The propagation experiments are one of major mission of Experimental Mobile Satellite System (EMSS) which is aimed for establishing basic technology for future general mobile satellite communication systems. A brief introduction is presented for the experimental results on propagation problems of ETS-5/EMSS. Author

N90-17952*# Ministry of Posts and Telecommunications, Kashima (Japan). Communications Research Lab.
PLAN OF ADVANCED SATELLITE COMMUNICATION EXPERIMENTS USING ETS-6
Tetsushi Ikegami *In* JPL, Proceedings of the 13th NASA Propagation Experimenters Meeting (NAPEX 13) 15 Aug. 1989 p 56-61 (For primary document see N90-17945 10-32)
Avail: NTIS HC A11/MF A02 CSCL 17B

In 1992, an Engineering Test Satellite 6 is scheduled to be launched by an H-2 rocket. The missions of ETS-6 are to establish basic technologies of inter-satellite communications using S-band, millimeter waves and optical beams and of fixed and mobile satellite communications using multibeam antenna on board the satellite. A plan of the experiments is introduced. Author

N90-17953*# Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Electrical Engineering.
LMSS MODELING STATUS REPORT
Warren L. Stutzman and R. Michael Barts *In* JPL, Proceedings of the 13th NASA Propagation Experimenters Meeting (NAPEX 13) 15 Aug. 1989 p 62-69 (For primary document see N90-17945 10-32)
Avail: NTIS HC A11/MF A02 CSCL 17B

The need to develop accurate models for secondary statistics of fading land mobile satellite signals has motivated a study of fading signal autocorrelations and multipath spectrum. Results of autocorrelations and power spectral densities from measured data are presented and comparisons to multipath spectrum models are made. Author

N90-17954*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
A CCIR AERONAUTICAL MOBILE SATELLITE REPORT
Faramaz Davarian, Dennis Bishop, David Rogers, and Ernest K. Smith (Colorado Univ., Boulder.) *In its* Proceedings of the 13th NASA Propagation Experimenters Meeting (NAPEX 13) 15 Aug. 1989 p 70-86 (For primary document see N90-17945 10-32)
Avail: NTIS HC A11/MF A02 CSCL 17B

Propagation effects in the aeronautical mobile-satellite service differ from those in the fixed-satellite service and other mobile-satellite services because: small antennas are used on aircraft, and the aircraft body may affect the performance of the antenna; high aircraft speeds cause large Doppler spreads; aircraft terminals must accommodate a large dynamic range in transmission and reception; and due to their high speeds, banking maneuvers, and three-dimensional operation, aircraft routinely require exceptionally high integrity of communications, making even short-term propagation effects very important. Data and models specifically required to characterize the path impairments are discussed, which include: tropospheric effects, including gaseous attenuation, cloud and rain attenuation, fog attenuation, refraction and scintillation; surface reflection (multipath) effects; ionospheric effects such as scintillation; and environmental effects (aircraft motion, sea state, land surface type). Aeronautical mobile-satellite systems may operate on a worldwide basis, including propagation paths at low elevation angles. Several measurements of multipath parameters over land and sea were conducted. In some cases, laboratory simulations are used to compare measured data and verify model parameters. The received signals is considered in terms of its possible components: a direct wave subject to atmospheric effects, and a reflected wave, which generally contains mostly a diffuse component. Author

N90-17955*# Dartmouth Coll., Hanover, NH. School of Engineering.
RAIN ATTENUATION MEASUREMENTS: VARIABILITY AND DATA QUALITY ASSESSMENT
Robert K. Crane *In* JPL, Proceedings of the 13th NASA Propagation Experimenters Meeting (NAPEX 13) 15 Aug. 1989 p 89-129 Submitted for publication (For primary document see N90-17945 10-32)
Avail: NTIS HC A11/MF A02 CSCL 17B

Year to year variations in the cumulative distributions of rain rate or rain attenuation are evident in any of the published measurements for a single propagation path that span a period of several years of observation. These variations must be described by models for the prediction of rain attenuation statistics. Now that a large measurement data base has been assembled by the International Radio Consultative Committee, the information needed to assess variability is available. On the basis of 252 sample cumulative distribution functions for the occurrence of attenuation by rain, the expected year to year variation in attenuation at a fixed probability level in the 0.1 to 0.001 percent of a year range is estimated to be 27 percent. The expected deviation from an attenuation model prediction for a single year of observations is estimated to exceed 33 percent when any of the available global rain climate model are employed to estimate the rain rate statistics. The probability distribution for the variation in attenuation or rain rate at a fixed fraction of a year is lognormal. The lognormal behavior of the variate was used to compile the statistics for variability. Author

N90-17956*# Johns Hopkins Univ., Laurel, MD. Applied Physics Lab.
RAIN CORE STRUCTURE STATISTICS DERIVED FROM RADAR AND DISDROMETER MEASUREMENTS IN THE MID-ATLANTIC COAST OF THE US
Julius Goldhirsh and Bert H. Musiani *In* JPL, Proceedings of the 13th NASA Propagation Experimenters Meeting (NAPEX 13) 15 Aug. 1989 p 130-137 (For primary document see N90-17945 10-32)
Avail: NTIS HC A11/MF A02 CSCL 17B

During a period spanning more than 5 years, low elevation radar measurements of rain were systematically obtained in the mid-Atlantic coast of the U.S. Drop size distribution measurements with a disdrometer were also acquired on the same rain days. The drop size data were utilized to convert the radar reflectivity factors to estimated rain rates for the respective rain days of operation. Applying high level algorithms to the rain data, core values of rain intensities were identified (peak rain rates), and families of rain rate isopleths analyzed. In particular, equicircle diameters of the family of isopleths enveloping peak rain intensities were statistically characterized. The presented results represents the analysis of two rain days, 12 radar scans, corresponding to 430 culled rain rate isopleths from an available data base of 22,000 contours, approximately 100 scans encompassing 17 rain days. The results presented show trends of the average rain rate vs. contour scale dimensions, and cumulative distributions of rain cell dimensions which belong to core families of precipitation. Author

N90-17957*# National Oceanic and Atmospheric Administration, Boulder, CO. Wave Propagation Lab.
OBSERVATIONS OF ATTENUATION AT 20.6, 31.65 AND 90.0 GHz: PRELIMINARY RESULTS FROM WALLOPS ISLAND, VA
J. B. Snider, M. D. Jacobson, and R. H. Beeler *In* JPL, Proceedings of the 13th NASA Propagation Experimenters Meeting (NAPEX 13) 15 Aug. 1989 p 138-144 (For primary document see N90-17945 10-32)
Avail: NTIS HC A11/MF A02 CSCL 17B

Ground based radiometric observations of atmospheric attenuation at 20.6, 31.65, and 90.0 GHz were made at Wallops Island, Virginia during April and May 1989. Early results from the analysis of the data set are compared with previous observations from California and Colorado. The relative attenuation ratios observed at each frequency during clear, cloudy, and rainy conditions are shown. Plans for complete analysis of the data are described. Author

N90-17958*# National Oceanic and Atmospheric Administration, Boulder, CO. Wave Propagation Lab.
RADIOMETRIC OBSERVATIONS AT 20.6, 31.65, AND 90.0 GHz: CONTINUING STUDIES
Ed R. Westwater, Michael J. Falls, and Ermanno Fionda (Fondazione Ugo Bordoni, Rome, Italy) *In* JPL, Proceedings of the 13th NASA Propagation Experimenters Meeting (NAPEX 13) 15 Aug. 1989 p 145-151 (For primary document see N90-17945 10-32)
Avail: NTIS HC A11/MF A02 CSCL 17B

Ground based radiometer measurements at 20.6, 31.65, and 90.0 GHz were analyzed to provide attenuation statistics, thus extending the data base of previous NAPEX studies. Using data from colocated radiosondes, comparisons of measurements and calculations of brightness temperatures are presented. The oxygen absorption model of Rosenkranz and the water vapor absorption models of Liebe and of Waters are used. Data from July 1987 at San Nicolas Island, California and from December 1987, August and November 1988 at Denver, Colorado, are included. Joint attenuation statistics at 20.6 and 31.65 GHz are presented for two locations of the Colorado Research Network for December 1987 and August 1988. Author

N90-17959*# Texas Univ., Austin. Electrical Engineering Research Lab.
LOW ELEVATION ANGLE KU-BAND SATELLITE MEASUREMENTS AT AUSTIN, TEXAS
Wolfhard J. Vogel, Geoffrey W. Torrence, and Murali Ranganathan *In* JPL, Proceedings of the 13th NASA Propagation Experimenters Meeting (NAPEX 13) 15 Aug. 1989 p 152-157 (For primary document see N90-17945 10-32)
(Contract INTEL-540B)
Avail: NTIS HC A11/MF A02 CSCL 17B

At low elevation angles, the propagation of satellite signals is affected by precipitation as well as by inhomogeneties of the refractive index. Whereas precipitation causes fades for relatively small percentages of time, the refractive index variability causes scintillations which can be observed for most of the time. An experiment is now under way in Austin, Texas, in which the right hand circularly polarized 12 GHz beacon of INTELSAT-V/F10 is observed at a 5.8 deg elevation angle, along with the radiometric sky temperature, rainfall rate, humidity, pressure, temperature, and wind speed and direction. The objective of these measurements is to accumulate a database over a period of 2 years and to analyze the probabilities and dynamical behavior of the signal variations in relation to the meteorological parameters. The hardware and software used for the data acquisition and analysis is described and the results from the first year of measurements are presented. Author

N90-17960*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
ATMOSPHERIC TRANSMISSION CALCULATIONS FOR OPTICAL FREQUENCIES
Kamran Shaik *In its* Proceedings of the 13th NASA Propagation Experimenters Meeting (NAPEX 13) 15 Aug. 1989 p 158-162 (For primary document see N90-17945 10-32)
Avail: NTIS HC A11/MF A02 CSCL 17B

A quantitative study of the transmission loss through the entire atmosphere for optical frequencies likely to be used for an earth-space communication link using existing data bases on scattering and absorption characteristics of the atmospheric constituents is presented. Author

N90-17961*# European Space Agency. European Space Research and Technology Center, ESTEC, Noordwijk (Netherlands).
RECENT ACHIEVEMENTS OF OPEX
Bertram Arbesser-Rastburg and Owen Turney *In* JPL, Proceedings of the 13th NASA Propagation Experimenters Meeting

(NAPEX 13) 15 Aug. 1989 p 163-168 (For primary document see N90-17945 10-32)
Avail: NTIS HC A11/MF A02 CSCL 17B

A group of propagation researchers have joined to prepare for a major campaign of propagation experiments for fixed satellite services using the Olympus satellite. For several years, the receiving hardware and data processing procedures have been planned, now, with the launch of the Olympus satellite imminent, experimenters are eager to start the real work. A short review is given of the accomplishments made since the last NAPEX meeting. Author

N90-17962*# Politecnico di Milano (Italy). Dipt. di Elettronica.
THE ITALSAT EXPERIMENT
A. Paraboni *In* JPL, Proceedings of the 13th NASA Propagation Experimenters Meeting (NAPEX 13) 15 Aug. 1989 p 169-188 (For primary document see N90-17945 10-32)
Avail: NTIS HC A11/MF A02 CSCL 17B

Some information is given on the ITALSAT millimetric waves propagation experiment, which is to be conducted with the ITALSAT satellite, whose launch is foreseen for the middle of 1990. The purpose of the experiment is one of experimenting with advanced technologies and techniques employing the 20/30 GHz bands in wideband telecommunications. Among the most qualified features of this system are the multispot antenna and the exchange function performed directly onboard. Details of the experiment are given. Author

N90-17963*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
ACTS PROPAGATION CONCERNS, ISSUES, AND PLANS
Faramaz Davarian *In its* Proceedings of the 13th NASA Propagation Experimenters Meeting (NAPEX 13) 15 Aug. 1989 p 216-221 (For primary document see N90-17945 10-32)
Avail: NTIS HC A11/MF A02 CSCL 17B

ACTS counters fading by resource sharing between the users. It provides a large margin only for those terminals which are at risk by unfavorable atmospheric conditions. ACTS, as an experimental satellite, provides a 5 dB clear weather margin and 10 dB additional margin via rate reduction and encoding. For the uplink, this margin may be increased by exercising uplink power control. Some of the challenges faced by the radiowave propagation community are listed. The issue of needs for the satellite are listed, both general and specific. Author

N90-17964*# Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Electrical Engineering.
US ACTIVITY WITH THE OLYMPUS SATELLITE
Warren L. Stutzman and Richard Campbell (Michigan Technological Univ., Houghton.) *In* JPL, Proceedings of the 13th NASA Propagation Experimenters Meeting (NAPEX 13) 15 Aug. 1989 p 222-228 (For primary document see N90-17945 10-32)
Avail: NTIS HC A11/MF A02 CSCL 17B

Future communication systems will move toward the 20 to 30 GHz frequency range for wider bandwidth and reduced interference, and will use small earth terminals. The ESA satellite OLYMPUS is scheduled for launch this June and will be ready for use in October. OLYMPUS has 12, 20, and 30 GHz beacons. Virginia Tech and Michigan Tech are working with NASA/JPL on an OLYMPUS experiment and hardware development program. OLYMPUS beacons provide coverage of the east coast of the US sufficient for attenuation measurements. The planned hardware for the OLYMPUS experiments is illustrated. The components of the experiment are summarized. A block diagram level overview of a typical channel is given and one of the four RF front ends is shown. Author

N90-17965# Naval Research Lab., Washington, DC.
REMOTE SENSING OF EVAPORATION DUCTS FOR NAVAL WARFARE Final Report, Jan. 1988 - Jan. 1989
G. L. Geernaert 14 Nov. 1989 29 p
(AD-A214849; NRL-9228) Avail: NTIS HC A03/MF A01 CSCL 20/14

Areas critical to naval operations are the prediction and application of atmospheric refractivity gradients. This report describes the use of the evaporation duct over the ocean and a plan for obtaining information about the evaporation duct by space-borne sensors. There has been little research on the theory and modeling of lower atmospheric refractivity, particularly evaporation ducts over a nonhomogeneous ocean over the past five decades. Much is known about surface layer similarity theory and propagation model techniques, but little attention has been placed on the spatial variabilities in the turbulent propagation medium (such as the atmospheric surface layer) in regions of strategic Navy interest. These regions include the coastal shelf, Gulf Stream, marginal ice zone, and those places where sharp sea surface temperature fronts exist. For tomorrow's Navy, using remote sensing techniques to infer evaporative and tropospheric ducts are a requirement. Although research efforts on ducts must couple the tropospheric and surface layer components, this report summarizes the state of the art for the evaporative duct and assess the potential of new and future results on improving next generation naval warfare capabilities. GRA

N90-17966# Arizona Univ., Tucson. Dept. of Computer Science.
THE SAGUARO DISTRIBUTED OPERATING SYSTEM Final Report, 1 Mar. 1988 - 28 Feb. 1989
Gregory R. Andrews and Richard D. Schlichting 24 May 1989 6 p
(Grant AF-AFOSR-0147-88; AF Proj. 2304)
(AD-A215083; AFOSR-89-1488TR) Avail: NTIS HC A02/MF A01 CSCL 12/5

The progress achieved over the final year of the Saguaro distributed operating system project is presented. The primary achievements were in related research, including SR distributed programming language, the MLP system for constructing distributed mixed-language programs, the Psync interprocess communication mechanism, a configurable operating system kernal called the x-kernal, and the development of language mechanisms for performing failure handling in distributed programming languages. GRA

N90-17967# Rome Air Development Center, Griffiss AFB, NY.
POLARIZATION RADAR PROCESSING TECHNOLOGY Report, 1985 - 1988
Kenneth C. Stiefvater, Russell D. Brown, Vincent C. Vannicola, and Michael C. Wicks Oct. 1989 66 p
(AD-A215242; RADC-TR-89-144) Avail: NTIS HC A04/MF A01 CSCL 17/9

A comprehensive effort is presented involving measurements and performance evaluation for the detection of scatters immersed in a background of natural and man-made clutter using polarization diverse waveforms. The effort spans evaluation from the initial stages of theoretical formulation to processor performance evaluation using real world data. The theoretical approach consists of determining polarimetric statistical properties of the backscatter waveform and the use of these properties to derive the optimum dual polarized S-Band radar system with selectable polarization on both transmit and receive. Recording equipment consists of 12 bit digital in-phase and quadrature channels indexed in time and phase for both polarizations. Several processors utilizing optimum and sub-optimum algorithms were evaluated using simulated and live radar data, and performance results were compared. The processor types include fully adaptive algorithms designed to operate on polarimetric spectral spread waveforms, and several combinations of single channel and polarization diverse receivers with both single and dual transmit polarization. A conventional fixed transmit and receive mode with no spectral processing is included. Comparisons are made between the various processors. The simulated and real data consist of randomly scattered dipoles, spheres, Swerling type scatters, and scatters of opportunity. GRA

N90-17968# Clarkson Univ., Potsdam, NY. Dept. of Mathematics and Computer Science.
NONLINEAR WAVE PROPAGATION Final Report, 1 Nov. 1987 - 31 Oct. 1989
Mark J. Ablowitz 22 May 1989 61 p
(Grant AF-AFOSR-0073-88; AF Proj. 2304)
(AD-A215500; AFOSR-89-1573TR) Avail: NTIS HC A04/MF A01 CSCL 12/1

We have been pursuing a number of research problems including: (1) development of solutions to multidimensional nonlinear evolution equations of physical significance. Prototypes are the so-called Kadomtsev-Petviashvilli and Davey-Stewartson equations. The nature of the boundary value problems and solutions of the equation in the so-called strong coupling limit were recently uncovered; (2) solutions of discrete nonlinear evolutions. In our studies we have found the following surprising situation. Associated with the integrable nonlinear Schrodinger equations are standard numerical schemes which exhibit at intermediate levels of mesh refinement, a weak form of temporal chaos. Differences schemes developed by Inverse Scattering Transform (IST) methods do not exhibit this spurious chaos. All schemes agree when the mesh is sufficiently refined; (3) inverse problems associated with multidimensional problems. A key element in this work is the DBAR method which has been extended from the study of two dimensional inverse problems, geophysics and acoustics; and (4) study of a class of cellular automata which admit solitons as a special solution. These systems are not reversible. GRA

N90-17969# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Systems and Logistics.
MODELING THE RESPONSE OF A MONOPULSE RADAR TO IMPULSIVE JAMMING SIGNALS USING THE BLOCK ORIENTED SYSTEM SIMULATOR (BOSS) M.S. Thesis
Jeffrey K. Long Sep. 1989 88 p
(AD-A215560; AFIT/GE/ENG/89D-26) Avail: NTIS HC A05/MF A01 CSCL 17/4

This theses developed computer models of two types of amplitude comparison monopulse processors using the Block Oriented System Simulation (BOSS) software package and to determine the response to these models to impulsive input signals. This study was an effort to determine the susceptibility of monopulse tracking radars to impulsing jamming signals. Two types of amplitude comparison monopulse receivers were modeled, one using logarithmic amplifiers and the other using automatic gain control for signal normalization. Simulations of both types of systems were run under various conditions of gain or frequency imbalance between the two receiver channels. The resulting errors from the imbalanced simulations were compared to the outputs of similar, baseline simulations which had no electrical imbalances. The accuracy of both types of processors was directly affected by gain or frequency imbalances in their receiver channels. In most cases, it was possible to generate both positive and negative angular errors, dependent upon the type and degree of mismatch between the channels. The system most susceptible to induced errors was a frequency imbalanced processor which used AGC circuitry. Any errors introduced will be a function of the degree of mismatch between the channels and therefore would be difficult to exploit reliably. GRA

N90-17970# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
AUTOMATION OF AN RCS (RADAR CROSS SECTION) MEASUREMENT SYSTEM AND ITS APPLICATION TO INVESTIGATE THE ELECTROMAGNETIC SCATTERING FROM SCALE MODEL AIRCRAFT CANOPIES M.S. Thesis
Scott A. Owens Dec. 1989 157 p
(AD-A215741; AFIT/GE/ENG/89D-38) Avail: NTIS HC A08/MF A01 CSCL 20/14

The purpose of this study was twofold, the first objective was to complete the development of AFIT's Far-Field Radar Range with a fully automated measurement process. The second objective was to use the facility to investigate the scattering of metallic versus transparent aircraft canopies relative to the scattering of the total aircraft. The approach for the investigation was: (1) to measure scale model aircraft to determine the effect of the RCS of the canopy/cockpit area on the RCS of the total aircraft; and (2) to design and measure a test body which would isolate the canopy/cockpit area from the rest of the aircraft. The result of the work on the first task is a software package called AFIT RCS Measurement Software (ARMS). The successful performance of the far-field range was validated by very favorable comparisons with the Wright Research and Development Center's anechoic chamber. The scale model measurements suggest at most a 5 dB difference between the scattering from the two extreme cases. The test body, however, clearly demonstrated differences up to 20 dB at certain frequencies. This study documents the upper and lower bounds of the subject measurements in an indoor measurement range. The Air Force has expressed interest in steering the investigation to examine materials and/or canopy construction. GRA

N90-17971# Ecole Nationale Superieure des Telecommunications, Paris (France). Dept. Signal.
ANTENNA DESIGN METHODS ADAPTED TO RADIO COMMUNICATION Ph.D. Thesis [METHODES DE TRAITEMENT D'ANTENNE ADAPTEES AUX RADIOCOMMUNICATIONS]
Luc Fety Jun. 1988 240 p In FRENCH Prepared in cooperation with Telecommunications Radioelectriques et Telephoniques, Le Plessis-Robinson, France
(TELECOM-88-E-018; ISSN-0751-1353; ETN-90-96107) Avail: NTIS HC A11/MF A01

The optimization of signal detection in the presence of interferences is studied by combination of received signals with reference to the original antenna radiation patterns. Multi-dimensional filtering based on source discrimination from received signals is examined. An algorithm is proposed to assure a fast convergence of the space filtering and a time synchronization. Problems related to space diversity are also discussed. ESA

N90-17972# Ecole Nationale Superieure des Telecommunications, Paris (France). Dept. Signal.
SPEECH SYNTHESIS: FROM SEGMENTAL SYNTHESIS TO ACOUSTIC RULES, USING TEMPORAL DECOMPOSITION Ph.D. Thesis [SYNTHESE DE LA PAROLE: DES SEGMENTS AUX REGLES, AVEC UTILISATION DE LA DECOMPOSITION TEMPORTELLE]
Frederic Bimbot Dec. 1988 220 p In FRENCH; ENGLISH summary
(TELECOM-88-E-019; ISSN-0751-1353; ETN-90-96108) Avail: NTIS HC A10/MF A01

Coherent speech analysis tools which allow the creation of a set of acoustic knowledge are proposed. The temporal decomposition technique describes a speech segment as a linear combination of a limited set of spectral targets, the time contribution of which is expressed by compact interpolation functions. A dictionary of spectral targets and a typology of temporal patterns can thus be created. A synthesis technique by structured segments is proposed as an intermediate step between segmental synthesis and rule based synthesis. Relations between experimental results and classical phonetic concepts are established. ESA

N90-17973# Ecole Nationale Superieure des Telecommunications, Paris (France). Dept. Signal.
UNSTEADY TWO LEVEL MODELS Ph.D. Thesis [MODELES NON-STATIONNAIRES A DEUX NIVEAUX]
A. DeLimaVeigaFilho Jun. 1989 175 p In FRENCH Sponsored by CAPES, Brazil
(TELECOM-89-E-006; ISSN-0751-1353; ETN-90-96109) Avail: NTIS HC A08/MF A01

The model proposed includes a second level with one part deterministic, formed by a linear combination of known functions, and another part which is purely stochastic. Estimation methods applicable to the case in which the stochastic part is a vectorial white noise are developed. A model used to describe the evolution of parameters in voice signal analysis is presented. Trajectories are described as the output of an autoregressive model excited

by a multiple steps function. It is shown that the stochastic coefficients approach allows an improvement of the estimation accuracy of the deterministic parameters. ESA

N90-17974# Ecole Nationale Superieure des Telecommunications, Paris (France).
CONTRIBUTION TO THE STUDY OF DESIGN METHODS FOR NUMERICAL FILTERS WITH FINITE PULSE RESPONSE AND APPLICATIONS TO IMAGE PROCESSING Ph.D. Thesis [CONTRIBUTION A L'ETUDE DES METHODES DE CONCEPTION DES FILTRES NUMERIQUES A REPONSE IMPULSIONNELLE FINIE ET APPLICATIONS AU TRAITEMENT D'IMAGES]
Pierre Siohan Mar. 1989 212 p In FRENCH
(TELECOM-89-E-007; ISSN-0751-1353; ETN-90-96110) Avail: NTIS HC A10/MF A01

An algorithm for the continuous synthesis of circular geometry two-dimensional filters is described. Optimum results are obtained for filters up to 15 by 15 dimension. Referring to quantified coefficient filters, the effects of rounding approximations are examined. The application to the HDMAC coding for high definition television is discussed. Results of several filter synthesis are presented. ESA

N90-17975*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
MULTIPLE SYMBOL DIFFERENTIAL DETECTION OF UNCODED AND TRELLIS CODED MPSK
Dariush Divsalar, Marvin K. Simon, and Mehrdad Shahshahani 15 Nov. 1989 74 p
(Contract NAS7-918)
(NASA-CR-186288; JPL-Publ-89-38; NAS 1.26:186288) Avail: NTIS HC A04/MF A01 CSCL 17B

A differential detection for MPSK, which uses a multiple symbol observation interval, is presented and its performance analyzed and simulated. The technique makes use of maximum-likelihood sequence estimation of the transmitted phases rather than symbol-by-symbol detection as in conventional differential detection. As such the performance of this multiple symbol detection scheme fills the gap between conventional (two-symbol observation) differentially coherent detection of MPSK and ideal coherent of MPSK with differential encoding. The amount of improvement gained over conventional differential detection depends on the number of phases, M, and the number of additional symbol intervals added to the observation. What is particularly interesting is that substantial performance improvement can be obtained for only one or two additional symbol intervals of observation. The analysis and simulation results presented are for uncoded and trellis coded MPSK. Author

N90-17976*# Computer Sciences Corp., Silver Spring, MD.
ADVANCED TRACKING SYSTEMS DESIGN AND ANALYSIS
R. Potash, L. Floyd, A. Jacobsen, K. Cunningham, A. Kapoor, C. Kwadrat, J. Radel, and J. McCarthy (EG and G Washington Analytical Services Center, Inc., Rockville, MD.) Sep. 1989 428 p
(Contract NAS5-31500)
(NASA-CR-183459; NAS 1.26:183459; CSC/TM-88/6060) Avail: NTIS HC A19/MF A03 CSCL 17I

The results of an assessment of several types of high-accuracy tracking systems proposed to track the spacecraft in the National Aeronautics and Space Administration (NASA) Advanced Tracking and Data Relay Satellite System (ATDRSS) are summarized. Tracking systems based on the use of interferometry and ranging are investigated. For each system, the top-level system design and operations concept are provided. A comparative system assessment is presented in terms of orbit determination performance, ATDRSS impacts, life-cycle cost, and technological risk. Author

N90-17977*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
PERFORMANCE MEASUREMENTS FOR A LABORATORY-SIMULATED 30/20 GHz COMMUNICATION SATELLITE TRANSPONDER
Robert J. Kerczewski and Gene Fujikawa 1990 10 p Presented at the 13th International Communication Satellite Systems Conference, Los Angeles, CA, 11-15 Mar. 1990; sponsored by AIAA
(NASA-TM-102424; E-5189; NAS 1.15:102424; AIAA-90-0808) Avail: NTIS HC A02/MF A01 CSCL 17B

NASA has developed a digital satellite communications system simulator and test bed facility, known as the Systems Integration, Test and Evaluation (SITE) Project. The purpose of the facility is to evaluate satellite system components, develop and verify system concepts, and perform satellite system experiments. A recently completed set of experiments measured the performance of the 30/20 GHz satellite transponder portion of the system in terms of RF parameters and high rate digital data transmission. The results of these tests indicate the quality of data transmission which can be obtained under various transponder conditions, as well as the relative effects of degraded RF performance on the bit-error rate (BER) of transmitted data. Author

N90-17978# Michigan Univ., Ann Arbor. Dept. of Electrical Engineering and Computer Science.
MILLIMETER WAVE RADAR CLUTTER PROGRAM Final Report, Oct. 1985 - Sep. 1989
Fawwaz T. Ulaby 30 Oct. 1989 211 p LIMITED REPRODUCIBILITY: Availability: Document partially illegible
(Contract DAAG29-85-K-0220)
(AD-A215772; ARO-22844.13-GS) Avail: NTIS HC A10/MF A02 CSCL 17/9

The overall goal of the program was to conduct experimental measurements and develop theoretical models to improve the understanding of electromagnetic wave interaction with terrain at millimeter wavelengths. The work was divided into five tasks. Tasks 1 involved the construction of calibrated scatterometer systems at 35, 94, and 140 GHz. In designing, constructing, and testing these systems, a great deal was learnt about system-design trade-offs and system stability requirements, and new calibration techniques were developed. The scatterometer systems were then used in support of the remaining tasks. The objective of Task 2 was to evaluate the effects of signal fading on the radar backscatter from terrain. Based on experiments conducted from asphalt and snow-covered surfaces, it was determined that the Rayleigh fading model is applicable at millimeter wavelengths, and a model was developed to show how frequency averaging can be used to reduce signal fading fluctuations. Task 3 involved the development of a model that relates the transmission loss of dry snow to crystal size in the 18 to 90 GHz region. In Task 4, the character of bistatic scattering from surfaces of various surface roughness and from two types of trees was examined. The bistatic data for trees proved instrumental in the development of a radar model for scattering from tree foliage at millimeter wavelengths, which was one component of Task 5. The other component of Task 5 involved the development of a model for snow. GRA

N90-17979# Massachusetts Inst. of Tech., Lexington. Lincoln Lab.
LOWER BOUNDS ON MULTIPLE-SOURCE DIRECTION FINDING IN THE PRESENCE OF DIRECTION-DEPENDENT ANTENNA-ARRAY-CALIBRATION ERRORS
A. R. Kurue 24 Oct. 1989 86 p
(Contract F19628-90-C-0002)
(AD-A215825; TR-799; ESD-TR-88-321) Avail: NTIS HC A05/MF A01 CSCL 20/15

We consider the problem of direction finding (DF) of multiple, cofrequency narrowband signals with a phased antenna array when direction-dependent array-calibration errors as well as thermal noise are present. Lower bounds on the variance of unbiased estimators for DF are derived under two different types of signal models: completely unknown (i.e., generic) signals and unknown

constant-envelope signals. In both models, the complex amplitudes of the signals are modeled as unknown parameters. We derive and evaluate lower bounds on DF of these signals when complex Gaussian array errors and thermal noise are present. In our numerical examples, the bound for generic signals tended to decrease with increasing interference power and, for closely spaced signals, became more optimistic when small array errors were added. With a sufficiently large signal-of-interest (SOI) array signal-to-noise power ratio (ASNR) and number of looks, the bound numerically approached the bound on DF of multiple generic signals with array errors but no thermal noise (i.e., the multiple-generic-signal, array-errors-only bound). The results for constant-envelope signals showed that the bound with array errors and thermal noise was more optimistic than the analogous generic-signal bound and had little dependence on signal separation and interference power. GRA

N90-17980# Massachusetts Inst. of Tech., Lexington. Lincoln Lab.
EVALUATION OF A DELAY-DOPPLER IMAGING ALGORITHM BASED ON THE WIGNER-VILLE DISTRIBUTION
K. I. Schultz 18 Oct. 1989 27 p
(Contract F19628-90-C-0002)
(AD-A215827; TR-855; ESD-TR-89-163) Avail: NTIS HC A03/MF A01 CSCL 17/9

This report investigates the relative merits of a delay-Doppler imaging radar based on matched filter and Wigner-Ville approaches. Both approaches are formally equivalent; the relative merits of each method are based solely on implementation issues. Given the current state of optical delay-Doppler radar and signal processing capabilities, the matched filter approach provides significant advantages over a Wigner-Ville-based approach. Additional applications of the Wigner-Ville distribution to laser radar measurements are discussed. GRA

N90-17981# IIT Research Inst., Chicago, IL.
ELF (EXTREMELY LOW FREQUENCY) COMMUNICATIONS SYSTEM ECOLOGICAL MONITORING PROGRAM: SUMMARY OF 1988 PROGRESS Technical Report, 1 Jan. - 31 Dec. 1988
John E. Zapotosky Nov. 1989 100 p
(Contract N00039-88-C-0065)
(AD-A216153; IITRI-E06620-1) Avail: NTIS HC A05/MF A01 CSCL 20/14

A long-term Ecological Monitoring Program is being conducted to monitor for possible effects from the operation of the U.S. Navy's ELF Communications System to resident biota and their ecological relationships. Monitoring studies were selected through a peer reviewed, competitive bidding process in mid-1982, and work on most studies began in late summer of that year. Preliminary activities of the Program consisted of site selection, characterization of critical study aspects, and validation of assumptions made in original proposal. Subsequently, increasing emphasis has been placed on the collection of preoperational and operational data bases at the Michigan and Wisconsin Transmitting Facilities. The data bases are being used to make proposed spatial and/or temporal comparisons of biological and ecological variables. This report summarizes the progress of the Ecological Monitoring Program during 1988. GRA

N90-17982# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
FRACTAL GEOMETRY SEGMENTATION OF POLARIMETRIC SYNTHETIC APERTURE RADAR IMAGES M.S. Thesis
Mark Allen Maneely Dec. 1989 116 p
(AD-A216278; AFIT/GE/ENG/89D-28) Avail: NTIS HC A06/MF A01 CSCL 17/9

This thesis describes how fractal geometry was used to segment synthetic aperture radar (SAR) images. The fractal dimension of each non-overlapping 8x8 pixel region in a 512x512 pixel image was estimated by use of a multidimensional extension of the box counting algorithm. The differences in estimated fractal dimensions were used to differentiate between regions. The SAR images used were represented by quantized surfaces. These surfaces were defined by nine different datasets of various Euclidean dimensions ranging from three to five. The degrees of freedom (Euclidean dimensions) of the datasets were the X and Y coordinates of each pixel and various combinations of power return values, magnitude return values and phase return values for each pixel. The SAR return values for four different SAR transmit and receive polarization configurations were determined by polarization synthesis techniques using the Stokes vectors of the transmitted and backscattered waves and the target reflectivity phase matrix. Phase matrix data for three different scenes was provided by the Jet Propulsion Laboratory, Pasadena, CA. Thesis results indicate that the fractal dimension of an image surface provides a useful method to segment SAR images. Comparisons between segmentations made using various datasets indicate that datasets containing the magnitude and phase return values yield more information helpful to image segmentation than do datasets containing only power return values. GRA

N90-17983# Mission Research Corp., Santa Barbara, CA.
PRPSIM: A FORTRAN CODE TO CALCULATE PROPERTIES OF RADIO WAVE PROPAGATION IN A STRUCTURED IONIZED MEDIUM. VOLUME 2: THEORY AND MODELS Technical Report, 31 Oct. 1987 - 31 Mar. 1989
R. E. Dodson, D. J. Krueger, and F. W. Guigliano 1 Dec. 1989 124 p
(Contract DNA001-85-C-0067)
(AD-A216299; MRC-R-1011-Vol-2; DNA-TR-87-162-V2-Vol-2)
Avail: NTIS HC A06/MF A01 CSCL 20/14

This report describes the PRPSIM (Properties of Radio Wave Propagation in a Structured Ionized Medium) code, a FORTRAN computer program for use in evaluating electromagnetic propagation effects resulting from detonation of nuclear weapons on satellite communications and radar systems. The code uses nuclear environment data files created by the SCENARIO high altitude, multiburst nuclear phenomenology code. PRPSIM calculates propagation effects due to enhanced mean ionization levels (e.g., absorption, noise, refraction, phase shift, Doppler and time delay variations, etc.). The code is written in ANSI FORTRAN-77 and has been installed and run on VAX, CDC/CYBER, ELXSI/EMBOS, and CRAY-1 computer systems. Volume 1 of the report is a user's guide which describes code installation, input, output, structure, and application. Volume 2 describes the underlying propagation effects theory and computational models. GRA

N90-17984# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
TRACKING A HYPERSONIC AIRCRAFT FROM A SPACE PLATFORM M.S. Thesis
David W. Ziegler Dec. 1989 117 p
(AD-A216399; AFIT/GA/ENY/89D-7) Avail: NTIS HC A06/MF A01 CSCL 17/11

This study developed a data processing algorithm for a space-based platform engaged in tracking a hypersonic transatmospheric vehicle. The geosynchronous platform was assumed to possess passive sensors measuring target position from data angles. The hypersonic vehicle was assumed to be operating in the outer fringes of the atmosphere. Four element and six element state Kalman filters were developed, coded, and tested against typical transatmospheric flight profiles. Accuracy of the filters in estimating position, velocity, heading, and acceleration was determined for 1, 5, and 10 second data intervals. From this test data, it was concluded that the six element state Kalman filter posed a viable option for tracking and estimating performance of hypersonic aircraft. GRA

N90-17985# Harry Diamond Labs., Adelphi, MD.
ON MULTIPLE EDGE DIFFRACTION AND MULTIPLE REFLECTIONS OF MICROWAVES OVER TERRAIN Final Report, Oct. 1986 - Nov. 1988
Albert G. Gluckman Nov. 1989 68 p Sponsored by Army Lab. Command, Adelphi, MD

(AD-A216418; HDL-TM-89-6) Avail: NTIS HC A04/MF A01 CSCL 20/14

This report describes a computer model which is an extension of the method of Deygout-Meeks for computing power density on target from microwaves propagated over terrain. The Meeks procedure is concerned with broadcast/isotropic radiation at very high frequencies (vhf) and accounts for the effects of diffraction across a single knife edge, as well as ground reflections of microwaves over electrically interactive terrain at low incidence angles of transmission. This model is extended to described broadcast vhf radiation or beamed microwaves that are diffracted over two edges. GRA

N90-17902*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

SIGNAL PROCESSING APPLIED TO PHOTOTHERMAL TECHNIQUES FOR MATERIALS CHARACTERIZATION Abstract Only

James A. Rooney *In its* Proceedings of the Second Noncontact Temperature Measurement Workshop 1 Jun. 1989 p 70 (For primary document see N90-17894 10-31)
Avail: NTIS HC A16/MF A03 CSCL 17B

33 ELECTRONICS AND ELECTRICAL ENGINEERING

Includes test equipment and maintainability; components, e.g., tunnel diodes and transistors; microminiaturization; and integrated circuitry.

For related information see also *60 Computer Operations and Hardware* and *76 Solid-State Physics.*

N90-17986# Technical Research Centre of Finland, Helsinki. Electrical Engineering Lab.

SPACE RADIATION EFFECTS ON ELECTRONICS

Arto Salminen Jan. 1989 80 p In FINNISH; ENGLISH summary
(DE90-602874; VTT-TIED-931; ISBN-951-38-3263-5; ISSN-0358-5085) Avail: NTIS (US Sales Only) HC A05/MF A01

The failure mechanisms and radiation hardening of electronic devices in spaceborne environment are considered. Radiation hardened components and radiation shielding of electronics are described. Because of the radiation belts and particle radiation from the Sun, the near earth space is hostile to electronics. Besides cosmic radiation represents fully random failure source, against which redundant methods have to be applied. Failures caused by absorbed doses can be dealt with by component selection, layout adjustment and addition of absorber. Prepairing for radiation damage presupposes the calculation of absorbed doses and SEU-cross sections from flight parameters. Thus the expected lifetime for spacecraft can be estimated. The above observations belong to the domain of normal routine operation in space electronic engineering and product assurance, which has a crucial meaning in space technology. Devices are to operate years without failure in demanding conditions. The reliable products are a result of careful consideration of space environment from the beginning of device design. This applies especially to component selection and circuit design. DOE

N90-17987*# Cincinnati Univ., OH. Dept. of Electrical and Computer Engineering.

ELECTRON-BEAM INDUCED DAMAGE IN THIN INSULATING FILMS ON COMPOUND SEMICONDUCTORS M.S. Thesis, 1988

Dragan M. Pantic Nov. 1989 121 p
(Contract NCC3-75)
(NASA-CR-185177; NAS 1.26:185177) Avail: NTIS HC A06/MF A01 CSCL 09A

Phosphorus rich plasma enhanced chemical vapor deposition (PECVD) of silicon nitride and silicon dioxide films on n-type indium phosphide (InP) substrates were exposed to electron-beam irradiation in the 5 to 40 keV range for the purpose of characterizing the damage induced in the dielectric. The electron-beam exposure was on the range of 10(exp -7) to 10(exp -3) C/sq cm. The damage to the devices was characterized by capacitance-voltage (C-V) measurements of the metal insulator semiconductor (MIS) capacitors. These results were compared to results obtained for radiation damage of thermal silicon dioxide on silicon (Si) MOS capacitors with similar exposures. The radiation induced damage in the PECVD silicon nitride films on InP was successfully annealed out in an hydrogen/nitrogen (H2/N2) ambient at 400 C for 15 min. The PECVD silicon dioxide films on InP had the least radiation damage, while the thermal silicon dioxide films on Si had the most radiation damage. Author

N90-17988# University of Southern California, Los Angeles. Dept. of Electrical Engineering.

AN ANALYSIS OF THE ANOMALOUS HIGH-CURRENT CATHODE EMISSION IN PSEUDOSPARK AND BACK-OF-THE-CATHODE LIGHTED THYRATRON SWITCHES

W. Hartmann, V. Dominic, G. F. Kirkman, and M. A. Gundersen 1 Jun. 1989 9 p Submitted for publication
(Grant AF-AFOSR-0093-88; AF Proj. 2301)
(AD-A215328; AFOSR-89-1310TR) Avail: NTIS HC A02/MF A01 CSCL 09/1

An analysis of the anomalously large cathode emission recently observed in the superdense glow of pseudospark and back-lighted thyratrons is presented. These switches are low-pressure (27 PaH2) glow-discharge pulsed-power devices. After operating at peak discharge currents of 6 to 8 kA and pulse durations of 0.5 to 1 microsec., the surface surrounding the cathode hole was found to have been homogeneously melted within a radius of approx. 4 mm indicating that the discharge is a superdense glow discharge, not an arc, with a cross-sectional area on the order of 1 sq cm. This conclusion is also supported by streak camera measurements. The current density at the cathode surface under these conditions is 5 to 10 kA/sq cm, several orders of magnitude larger than that of thermionic cathodes in common thyratrons. This high-current density is explained by intense cathode heating from a high-current density ion beam produced in the cathode fall during the initial stage of current buildup. The surface heating resulting from this beam yields a significant field-enhanced thermionic emission of electrons. GRA

N90-17989# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

RIGOROUS CALCULATIONS OF LUMPED ELECTRICAL PARAMETERS FOR A MICROSTRIP INTERDIGITATED ELECTRODE STRUCTURE M.S. Thesis

Henry P. Leal Dec. 1989 179 p
(AD-A215337; AFIT/GE/MA/89D-1) Avail: NTIS HC A09/MF A01 CSCL 20/3

This research investigates a microstrip interdigitated electrode structure used in integrated circuit sensors and presents an electrical model for the device. The structure is assumed to: (1) have a periodic arrangement of interdigitated electrodes, (2) have electrodes of sufficient length to ignore effects created by the ends of the structure, (3) be operating at a sufficiently low frequency, where the potential is essentially constant along the electrode's length and where the substrate is essentially a conductor, and finally (4) have five layers of homogeneous, isotropic, non-magnetic material in the plane transverse to the structure's length. Within these constraints, the problem focuses on solving for the potential distribution using Laplace's equation. The electrical model developed consists of three elements--a capacitance from each of two electrodes to ground, a capacitance between the electrodes, and a resistance through the sensor coating. The values for the individual elements are found from the potential solution. Potential functions, in the form of infinite Fourier series, are developed for each layer within a periodic cell. The coefficients of the Fourier series are determined by matching boundary conditions across interfaces between the material layers. GRA

N90-17990# Institut National des Sciences Appliquees, Lyon (France).
STUDY AND IMPLEMENTATION OF A MONOLITHIC PHOTORECEIVER INTEGRATING A PHOTODIODE AND A JUNCTION FIELD EFFECT TRANSISTOR IN GaInAs WITH POLARIZATION RESISTANCE Ph.D. Thesis [ETUDE ET REALISATION D'UN PHOTORECEPTEUR MONOLITHIQUE INTEGRANT UNE PHOTODIODE ET UN TRANSISTOR A EFFET DE CHAMP A JONCTION EN GAINAS AVEC RESISTANCE DE POLARISATION]
Jean-Charles Renaud Feb. 1989 200 p In FRENCH Sponsored by the Commission of European Communities
(IDI-18902; ETN-90-96106) Avail: NTIS HC A09/MF A02

Noise spectra in PIN-FET photodiode-amplifier systems are investigated, and a model is developed giving the sensitivity of the receptor. The technological procedures used to manufacture the integrated system are detailed. The passivation and ion gun forming procedures are optimized. The performance of the experimental device is limited by the level of noise generated. ESA

N90-17991# Avco-Everett Research Lab., MA.
LIGHTWEIGHT TRANSFORMER DEMONSTRATION Semiannual Status Report, 1 Oct. 1988 - 31 Mar. 1989
1989 14 p
(Contract DE-AC22-87PC-79676)
(DE90-001470; DOE/PC-79676/T1) Avail: NTIS HC A03/MF A01

The objective is to support highly focused, innovative, fundamental/applied research approaches that will complement the Feasibility Assessment program for Space Based, Multimegawatt, MHD Power Systems. The program consists of a series of related tasks described as follows: (1) Analysis and optimization of the proposed cryogenically cooled air core transformer. The nominal input power into the transformer shall be 400 kW switched at 1 kHz. Following optimization of the proposed conceptual design, the contractor shall perform an engineering design of the transformers in sufficient detail to permit outside vendor fabrication. The design will be suitable for subsequent scale up to multimegawatt power level for space based applications; (2) Transformer procurement and assembly; (3) Performance of low power (up to hundreds of volt-amperes), room temperature and cryogenic testing. The measurements shall include the impedance, self inductance, parasitic inductance and capacitance of each coil and their mutual inductance. These measurements shall be performed at room, liquid nitrogen, and liquid hydrogen temperature; and (4) Performance of full power transformer testing under cryogenic (liquid hydrogen) conditions utilizing the existing Avco Mk VI MHD facility equipment which includes the Mk VI current control circuits, magnet power supply and channel load. The nominal input power level shall be 400 kW, 1 kHz square wave. The electrical measurements performed in Task 3 shall be repeated in this task. DOE

N90-17992# Los Alamos National Lab., NM.
MEGAWATT-KLYSTRON AMPLIFIERS IN L-BAND
G. Schaffer 1989 16 p Presented at the SSC-Linac Workshop, Dallas, TX, 7 Jul. 1989
(Contract W-7405-eng-36)
(DE90-004864; LA-UR-89-4241; CONF-8906271-1) Avail: NTIS HC A03/MF A01

A short guide is presented for the SSC-Linac Injector Workshop. It contains a general overview of historical development and of modern design of L-band klystron amplifiers in the range of about 1 to 30 Megawatt output (CW or pulse). Absolute power limits, efficiency, modulation characteristics, protection devices and typical application examples are briefly considered. It should be mentioned that this overview is not restricted to specific needs of the SSC-Injector Linac. DOE

N90-17993# Sandia National Labs., Albuquerque, NM. Discrete Semiconductors Div.
CHARACTERIZATION AND DEVELOPMENT REPORT FOR THE SA3124, A 15-VOLT ZENER DIODE
J. B. Vinson, A. M. Gurule, and D. K. Holck Sep. 1989 37 p
(Contract DE-AC04-76DP-00789)
(DE90-005711; SAND-89-2266) Avail: NTIS HC A03/MF A01

The SA3124 is a silicon zener diode designated as a JANTXV1N965B-1 device manufactured by Microsemi of Scottsdale, Arizona. The devices were procured from Microsemi and tested by the Design Agency in accordance with PS319094. The SA3124 is a 15 V zener diode packaged in a DO-35 cylindrical lead silicate glass package. The monolithic silicon die is sandwiched between two copper-clad Dumet plugs wth coaxial copper-clad and tin-dipped iron leads welded to them. DOE

N90-17994# Central Research Inst. of Electric Power Industry, Tokyo (Japan). Energy and Environment Lab.
DEVELOPMENTAL CONDITION AND TECHNICAL PROBLEMS ON ELECTRIC INSULATION FOR SUPER-CONDUCTING ELECTRIC POWER MACHINE
H. Motoyama May 1989 35 p In JAPANESE; ENGLISH summary
(DE90-741973; CRIE-T-88094) Avail: NTIS (US Sales Only) HC A03/MF A01

The present situations of superconducting electric power machines in the world and studied problems were investigated from viewpoint of the electric insulation. 50MVA generator (CRIE/Hitachi) or 120MVA generator (KWU/Siemens) where the dc superconducting technique was applied on field windings, are developed. As to Superconducting transformer, 220KVA transformer is trially manufactured and the conceptual design of 1,000MVA transformer is made by W.H. or Alstom. Future problems are the study of protecting method for the overvoltage to superconducting electric power machines and the study to prevent the quench for superconducting windings. The respective insulating characteristics of solid and liquid insulators become clear gradually under the cryogenic condition but a large part of insulating characteristics of composite insulator prepared by combination of both insulators are not clear, so that these problems must be clarified. DOE

N90-17995# Federal Aviation Administration, Atlantic City, NJ.
BROADBAND VERSUS NARROWBAND DRIVER/POWER AMPLIFIER: A SPECTRAL PURITY COMPARISON
Arthur W. Cushman and Philip J. Randazzo Mar. 1990 17 p
(DOT/FAA/CT-TN89/73) Avail: NTIS HC A03/MF A01

The very high frequency (VHF) and ultra high frequency (UHF) series communications transmitters used in the field by the Federal Aviation Administration (FAA) Technical Center were originally equipped with narrowband amplifiers designed specifically for their respective frequency ranges. Systems manufactured after August 1983 were provided with a new broadband VHF/UHF driver/power amplifier module. This unit was designed to unify the previously separate functions performed by the individual VHF and UHF narrowband driver/power amplifiers. This report describes spectral purity tests performed at the FAA on two each GRT-21 (VHF) and one GRT-22 (UHF) series 10-watt communication transmitters. The purpose of this investigation was the determine if the new driver/power amplifier module generates noise levels sufficient to desensitize nearby receivers. Test measurements show no significant difference in the spectral purity of the old (narrowband) driver/power amplifier and the new (broadband) driver/power amplifier. Author

N90-17996# California Univ., Berkeley. Electronics Research Lab.
RESEARCH ON MONOLITHIC MILLIMETER-WAVE DEVICES Final Report, 1 Aug. 1985 - 31 Jul. 1989
Steven E. Schwarz 25 Oct. 1989 58 p
(Contract DAAG29-85-K-0182)
(AD-A215771; ARO-22632.3-EL) Avail: NTIS HC A04/MF A01 CSCL 09/1

The main thrust of this research was toward improvement of oscillators for planar microwave and millimeter-wave circuits. There is a need for local oscillators in receivers; for power oscillators in transmitters; and for arrays of both in scanning radar arrays. In all sorts of oscillators, power drops off as frequency increases. Thus, new techniques were sought through which power may be increased. For most applications it is desirable to have low noise as well. Transferred electron (including Gunn) oscillators were closely studied. The concept of multi-domain Gunn diodes was developed. Horizontal devices lend themselves much more readily to the fabrication techniques used in MMICs, resulting in simpler structures. Broadband negative resistance can be obtained, suggesting the possibility of widely tunable voltage-tuned oscillators. The design of resonators for planar oscillators was also studied. A well known problem in MMIC technology is the difficulty of making adjustments on a circuit once it was fabricated. Ways were investigated of making such adjustments. Another component of the work has concerned a technique for making measurements on working MMICs. Lastly, the interesting physical problem of low frequency oscillations in semi-insulating gallium arsenide was also investigated. It is found that when a small electric field is applied to this material, low frequency (audio) current oscillations are observed. GRA

N90-17997# Rome Air Development Center, Griffiss AFB, NY.
FINITE ELEMENT MODELING AND THERMAL SIMULATIONS OF TRANSISTOR INTEGRATED CIRCUITS In-House Report, Apr. 1988 - Mar. 1989
William J. Bocchi Oct. 1989 63 p
(AF Proj. P412)
(AD-A215928; RADC-TR-89-176) Avail: NTIS HC A04/MF A01 CSCL 17/9

This report documents finite element thermal simulations of the driver amplifier of a C-band transmit/receive radar module currently under life test at the Rome Air Development Center. Steady state and transient finite element thermal simulations were performed to determine the temperature distribution within the gate regions of the transistor cells of a gallium arsenide chip. Other accomplishments include identification of the proper finite element modeling procedures and techniques and investigation of correlating infrared thermal measurements with finite element analytical results. GRA

N90-17998# Naval Ocean Systems Center, San Diego, CA.
SUGGESTIONS FOR DESIGNERS OF NAVY ELECTRONIC EQUIPMENT, 1989 EDITION, REVISION B
Jul. 1989 146 p
(AD-A215961; NOSC/TD-250-Rev-B) Avail: NTIS HC A07/MF A01 CSCL 09/1

This booklet is designed to serve as a handy checklist for engineers during the development of naval electronic equipment. The objectives are to save engineering, development, and testing time and effort, and to increase operational availability of better electronic equipment. The suggestions are intended for equipment developed for the Navy, although most of them apply to all types of military electronic equipment. This publication is not to be regarded as a substitute for military standards and specifications. Such documents can be obtained from the contracting agency concerned. GRA

N90-17999# Litton Systems, Inc., San Carlos, CA. Electron Devices Div.
[DEVELOPMENT OF A SMALL SIGNAL THEORY FOR THE HARMONIC GYROKLYSTRON] Final Report
1 Apr. 1989 170 p
(Contract N00014-87-C-2523)
(AD-A216274) Avail: NTIS HC A08/MF A01 CSCL 09/1

A small signal theory for the harmonic gyroklystron (HGK) was developed. The theory uses approximate analytical solutions for the cavity fields of vaned magnetron-like cavities. A computer program called SSHGK was written to calculate the small signal gain, resonant frequency, R/Q Q(0), and related quantities for a given set of cavity dimensions, beam parameters, magnetic field, and cavity loading. Program results indicate that there are broad ranges of input parameters which will produce acceptable small signal gain at the second and third cyclotron harmonics. A representative design was outlined for 35 GHz operation at the second cyclotron harmonic. An electron gun and magnetic focusing system was designed to generate the required thin, hollow, axis encircling electron beam. This integrated gun and focusing system was developed and modeled to easily generate the desired beam trajectories and cross section. This new design produces beams with high ratios of transverse to longitudinal momentum (alpha), and low velocity spreads required by gyro-amplifiers such as the HGK. Using this design, a given gun structure can produce electron beams with adjustable alphas, beam radii, beam currents, annular widths, and velocity spreads just by changing the electrode voltages and magnetic field profile. GRA

N90-18000# Sandia National Labs., Albuquerque, NM. IC Failure Analysis Div.
A NEW TECHNIQUE FOR IMAGING THE LOGIC STATE OF PASSIVATED CONDUCTORS: BIASED RESISTIVE CONTRAST IMAGING
Edward I. Cole, Jr. 1990 2 p Presented at the International Reliability Physics Symposium, New Orleans, LA, 26-29 Mar. 1990
(Contract DE-AC04-76DP-00786)
(DE90-000666; SAND-89-2384C; CONF-900304-1) Avail: NTIS HC A01/MF A01

A new scanning electron microscopy imaging technique has been developed to examine the logic state of conductors on passivated CMOS integrated circuits. This technique employs a modified Resistive Contrast Imaging system to acquire image data on powered devices. The image is generated by monitoring subtle shifts in the power supply current of an integrated circuit as an electron beam is scanned over the device surface. The images produced with this new technique resemble voltage contrast data from devices with the passivation removed and the surface topography subtracted. Non-destructive applications of this imaging method to functional and failed integrated circuits are described. Possible irradiation effects and methods to minimize them are also discussed. DOE

N90-17688# European Space Agency. European Space Research and Technology Center, ESTEC, Noordwijk (Netherlands).
THERMAL CHARACTERISTICS OF POWER MOS-FETS. RESULTS OBTAINED WITH THE IRF-250
C. Delettrez and H. J. N. Spruyt *In its* European Space Power, Volume 1 Aug. 1989 p 71-77 (For primary document see N90-17678 10-20)
Copyright Avail: NTIS HC A19/MF A03

N90-17702# MATRA Espace, Toulouse (France).
ELECTRICAL BATTERY MODEL FOR LEO APPLICATION BASED ON ABSOLUTE INSTANTANEOUS STATE OF CHARGE
A. Lehman *In* ESA, European Space Power, Volume 1 Aug. 1989 p 173-178 (For primary document see N90-17678 10-20)
Avail: NTIS HC A19/MF A03

N90-17703# Societe des Accumulateurs Fixes et de Traction, Romainville (France).
MATHEMATICAL MODELLING AND EXPERT SYSTEM FOR BATTERY MANAGEMENT
Jacques Boscher, Pascal Marrot, and Karim Bouridah (European Space Agency. European Space Research and Technology Center, ESTEC, Noordwijk, Netherlands) *In* ESA, European Space Power, Volume 1 Aug. 1989 p 179-185 (For primary document see N90-17678 10-20)
Copyright Avail: NTIS HC A19/MF A03

N90-17704# Danish Research Center for Applied Electronics, Hoersholm.
THERMAL STUDY OF BATTERY CHARGE CONTROL BY TEMPERATURE DERIVATIVE REDUCTION
P. HalkjaerJacobsen, K. A. Schmidt, S. Otto, G. J. Dudley, and H. J. N. Spruijt (European Space Agency. European Space Research and Technology Center, ESTEC, Noordwijk, Netherlands) *In* ESA, European Space Power, Volume 1 Aug. 1989 p 187-192 (For primary document see N90-17678 10-20)
Copyright Avail: NTIS HC A19/MF A03

N90-17705# British Aerospace Public Ltd. Co., Stevenage (England). Space Systems Div.
THE GROUND TESTING OF NICKEL HYDROGEN BATTERIES PRIOR TO LAUNCH
B. D. Cox and P. Leggett (European Space Agency. European Space Research and Technology Center, ESTEC, Noordwijk, Netherlands) *In* ESA, European Space Power, Volume 1 Aug. 1989 p 193-199 (For primary document see N90-17678 10-20)
Copyright Avail: NTIS HC A19/MF A03

N90-17712# Technische Univ., Graz (Austria).
WATER REMOVAL STUDIES ON HIGH POWER HYDROGEN-OXYGEN FUEL CELLS WITH ALKALINE ELECTROLYTES
K. Kordesch, J. C. T. Oliveira, Ch. Gruber, and G. Winkler *In* ESA, European Space Power, Volume 1 Aug. 1989 p 239-244 Sponsored by the Austrian Fonds zur Foerderung der Wissenschaftlichen and CNPq, Brazil (For primary document see N90-17678 10-20)
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N90-17716# European Space Agency. European Space Research and Technology Center, ESTEC, Noordwijk (Netherlands).
LOW EARTH ORBIT NICKEL CADMIUM BATTERY LIFETIME TESTING
B. Hendel and G. J. Dudley *In its* European Space Power, Volume 1 Aug. 1989 p 265-270 (For primary document see N90-17678 10-20)
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N90-17721# Technische Univ., Delft (Netherlands). Lab. for Power Electronics.
PWM CONVERTER TOPOLOGIES
E. R. W. Meerman and H. J. N. Spruyt (European Space Agency. European Space Research and Technology Center, ESTEC, Noordwijk, Netherlands) *In* ESA, European Space Power, Volume 1 Aug. 1989 p 297-305 (For primary document see N90-17678 10-20)
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N90-17722# Ecole Nationale Superieure de Mecanique et d'Aerotechnique, Poitiers (France).
APPLICATION OF A BUCK-TYPE MC2 REGULATED CONVERTER FOR A STEPPER MOTOR CONTROL
M. deColigny, L. J. Dullaart, R. Rodriguez (SEEP Engineering, France), M. Capdepuy, A. Capel, and A. Battle *In* ESA, European Space Power, Volume 1 Aug. 1989 p 307-309 (For primary document see N90-17678 10-20)
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N90-17723# Centre National d'Etudes Spatiales, Toulouse (France).
CURRENT PROTECTIONS MODELISATION IN A BUCK CELL
A. Barnaba *In* ESA, European Space Power, Volume 1 Aug. 1989 p 311-316 (For primary document see N90-17678 10-20)
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N90-17724# Fabrica Italiana Apparecchiature Radioelettriche S.p.A., Milan.
THE 120V 20A PWM SWITCH FOR APPLICATIONS IN HIGH POWER DISTRIBUTION
V. Borelli and W. Nimal (Etudes Techniques et Constructions Aerospatiales, Charleroi, Belgium) *In* ESA, European Space Power, Volume 1 Aug. 1989 p 317-321 (For primary document see N90-17678 10-20)
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N90-17726# Loughborough Univ. of Technology (England).
AN ASSESSMENT OF THE USE OF RESONANT-MODE TOPOLOGIES FOR HIGH FREQUENCY POWER CONVERSION
S. H. Weinberg and C. D. Manning *In* ESA, European Space Power, Volume 1 Aug. 1989 p 331-337 (For primary document see N90-17678 10-20)
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N90-17727# Universidad de Oviedo, Gijon (Spain). Dept. de Ingenieria Electrica, Electronica, Computadores y Sistemas.
A NEW VISION TO MODEL THE PARALLEL RESONANT CONVERTER
M. Rico, J. Sebastian, J. Uceda (Universidad Politecnica de Madrid, Spain), and M. A. Perez *In* ESA, European Space Power, Volume 1 Aug. 1989 p 339-344 (For primary document see N90-17678 10-20)
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N90-17728# Escuela Tecnica Superior de Ingenieros Industriales, Gijon (Spain). Dept. de Ingenieria Electrica y Electronica.
DESIGN OF A POWER SUPPLY SYSTEM BASED IN TWO QUASI-RESONANT CONVERTERS
M. A. Perez, J. Sebastian, J. Uceda, F. Nuno, J. A. Martinez, and J. Cezon (INISEL, Torrejon de Ardoz, Spain) *In* ESA, European Space Power, Volume 1 Aug. 1989 p 345-350 (For primary document see N90-17678 10-20)
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N90-17729# Loughborough Univ. of Technology (England).
TECHNIQUES FOR HIGH FREQUENCY POWER CONVERSION
S. H. Weinberg and C. D. Manning *In* ESA, European Space Power, Volume 1 Aug. 1989 p 351-356 (For primary document see N90-17678 10-20)
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N90-17730# Gdansk Technical Univ. (Poland). Inst. of Electronic Technology.
DYNAMICAL MODEL OF SERIES-RESONANT CONVERTER WITH PEAK CAPACITOR VOLTAGE PREDICTOR AND SWITCHING FREQUENCY CONTROL
A. Pietkiewicz, D. Tollik, and J. B. Klaassens (Technische Univ., Delft, Netherlands) *In* ESA, European Space Power, Volume 1 Aug. 1989 p 357-360 (For primary document see N90-17678 10-20)
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N90-17731# TRW Systems Group, Redondo Beach, CA. Space and Technology Group.
INNOVATIONS IN THE DESIGN AND MATCHING OF MAGNETIC COMPONENTS AND SEMICONDUCTORS UP PERFORMANCE AND RELIABILITY OF POWER CONVERTERS
H. E. Gavira *In* ESA, European Space Power, Volume 1 Aug. 1989 p 361-366 (For primary document see N90-17678 10-20)
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N90-17733# Escuela Tecnica Superior de Ingenieros de Telecomunicacion, Barcelona (Spain).
LINEAR AND NON-LINEAR CONTROL OF HIGH-ORDER CONVERTERS AFTER REDUCING THE ORDER BY APPROPRIATE TECHNIQUES
A. Poveda, L. Martinez, J. Majo, L. GarciadeVicuna, F. Guinjoan,

and M. Valentin (Laboratoire d'Automatique et d'Analyse des Systemes, Toulouse, France) *In* ESA, European Space Power, Volume 1 Aug. 1989 p 375-380 (For primary document see N90-17678 10-20)
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N90-17734# Pisa Univ. (Italy). Inst. of Electricity.
VARIABLE STRUCTURE CONTROL SYSTEM APPLIED TO MULTILEVEL POWER CONDITIONING CONVERTERS
D. Casini, M. Marchesoni, and L. Puglisi (Genoa Univ., Italy) *In* ESA, European Space Power, Volume 1 Aug. 1989 p 381-388 (For primary document see N90-17678 10-20)
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N90-17735# Alcatel Espace, Toulouse (France).
STATE VARIABLE MODELLING FOR THE AUDIOSUSCEPTIBILITY EVALUATIONS OF CURRENT CONTROLLED ZERO RIPPLE STRUCTURES
A. Capel and J. C. Marpinard (Laboratoire d'Automatique et d'Analyse des Systemes, Toulouse, France) *In* ESA, European Space Power, Volume 1 Aug. 1989 p 389-397 (For primary document see N90-17678 10-20)
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N90-17736# Laboratoire d'Automatique et d'Analyse des Systemes, Toulouse (France).
HIGH SPEED DIGITAL CONTROL OF HIGH FREQUENCY PWM CONVERTERS
J. C. Marpinard, P. Bidan, and J. M. Hernandez (Centro de Ensenanza Tecnica Industrial, Guadalajaro, Mexico) *In* ESA, European Space Power, Volume 1 Aug. 1989 p 399-402 (For primary document see N90-17678 10-20)
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N90-17737# Technische Univ., Vienna (Austria). Power Electronics Section.
COMPARISON OF CONTROL STRUCTURES FOR A BIDIRECTIONAL HIGH-FREQUENCY dc-dc CONVERTER
Felix A. Himmelstoss, Johann W. Kolar, and Franz C. Zach *In* ESA, European Space Power, Volume 1 Aug. 1989 p 403-408 Sponsored by the Austrian Fonds zur Foerderung der Wissenschaftlichen (For primary document see N90-17678 10-20)
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N90-17738# Politecnico di Milano (Italy).
ANALYSIS OF THE CUK CONVERTER IN DELTA V MODE BY CHARGE AND FLUX BALANCES
P. Maranesi, L. Pinola, V. Varoli, and G. F. Volpi (LABEN Ferranti International, Vimodrone, Italy) *In* ESA, European Space Power, Volume 1 Aug. 1989 p 409-413 (For primary document see N90-17678 10-20)
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N90-17739# European Space Agency. European Space Research and Technology Center, ESTEC, Noordwijk (Netherlands). Power and Energy Conversion Division.
SIMPLE POLE/ZERO MODELLING OF CONDUCTANCE CONTROLLERS
D. OSullivan and A. Crausaz *In its* European Space Power, Volume 1 Aug. 1989 p 415-423 (For primary document see N90-17678 10-20)
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N90-17740# CONACyT, Cuernavaca (Mexico).
MODELLING THE BUCK-TYPE CONVERTER TRANSIENT RESPONSE WITH PULSATING LOAD
J. Arau, J. Cezon, F. Aldana, and J. Uceda (Universidad Politecnica de Madrid, Spain) *In* ESA, European Space Power, Volume 1 Aug. 1989 p 425-432 (For primary document see N90-17678 10-20)
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N90-17741# Alcatel Espace, Toulouse (France).
A COMPLETE EPC SIMULATION
C. Peyrotte and J. Y. Lebas *In* ESA, European Space Power, Volume 1 Aug. 1989 p 435-441 (For primary document see N90-17678 10-20)
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N90-17742# BBN Communications A/S, Ballerup (Denmark).
LOW NOISE, HIGH VOLTAGE SUPPLY FOR CARCINOTRON BACKWARD WAVE OSCILLATORS
F. H. Pedersen and J. C. J. Eeman (European Space Agency. European Space Research and Technology Center, ESTEC, Noordwijk, Netherlands) *In* ESA, European Space Power, Volume 1 Aug. 1989 p 443-450 (For primary document see N90-17678 10-20)
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N90-17743# ANT Nachrichtentechnik, Backnang (Germany, F.R.).
INTRINSIC PROPERTIES OF HIGH VOLTAGE WIRES THAT MAY CAUSE SPORADIC DISCHARGES IN SPACE VACUUM
Klaus H. Geissler *In* ESA, European Space Power, Volume 1 Aug. 1989 p 451-455 (For primary document see N90-17678 10-20)
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N90-17744# Dornier System G.m.b.H., Friedrichshafen (Germany, F.R.).
POWER CONDITIONING FOR ACTIVE ARRAY SAR ANTENNAS
W. Schaeper *In* ESA, European Space Power, Volume 1 Aug. 1989 p 457-461 (For primary document see N90-17678 10-20)
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N90-17745# Padua Univ. (Italy). Dept. of Electrical Engineering.
ANALYSIS OF THE BEHAVIOUR OF A CURRENT-FED MULTI-STAGE VOLTAGE MULTIPLIER WITH CAPACITIVE OUTPUT
Paolo Tenti, Leopoldo Rossetto, Luigi Malesani, Ingo Arens, Elena Gaio, Roberto Piovan, Arnaldo Bonati, and Fabio Mazzocco (Fabrica Italiana Apparecchiature Radioelettriche S.p.A., Milan.) *In* ESA, European Space Power, Volume 1 Aug. 1989 p 463-469 (For primary document see N90-17678 10-20)
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N90-17746# Padua Univ. (Italy). Dept. of Electrical Engineering.
ANALYSIS AND DESIGN OF A HV dc/dc SERIES RESONANT CONVERTER USING A MULTI-STAGE VOLTAGE MULTIPLIER
Paolo Tenti, Leopoldo Rossetto, Luigi Malesani, Ingo Arens, Elena Gaio, Roberto Piovan, Arnaldo Bonati, and Fabio Mazzocco (Fabrica Italiana Apparecchiature Radioelettriche S.p.A., Milan.) *In* ESA, European Space Power, Volume 1 Aug. 1989 p 471-477 (For primary document see N90-17678 10-20)
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N90-17747# European Space Agency. European Space Research and Technology Center, ESTEC, Noordwijk (Netherlands).
HIGH POWER MEDIUM VOLTAGE ELECTRONIC LOAD
M. Martin and H. J. N. Spruijt *In its* European Space Power, Volume 1 Aug. 1989 p 479-484 (For primary document see N90-17678 10-20)
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34 FLUID MECHANICS AND HEAT TRANSFER

Includes boundary layers; hydrodynamics; fluidics; mass transfer; and ablation cooling.

For related information see also *02 Aerodynamics* and *77 Thermodynamics and Statistical Physics.*

N90-18001 Stanford Univ., CA.
NUMERICAL STUDIES ON LAMINAR-TURBULENT TRANSITION IN BOUNDARY LAYERS Ph.D. Thesis
Kyung Soo Yang 1989 169 p
Avail: Univ. Microfilms Order No. DA8919491

Laminar-turbulent transition in flat-plate boundary layers is investigated by direct numerical solution of the full Navier-Stokes equations. Both forced transition (in parallel Blasius flow excited by a vibrating ribbon) and natural transition (in a decelerating boundary layer) are studied. In both cases, an initial state containing random noise is employed to eliminate bias in selecting unstable waves. In the simulations of ribbon-induced transition, close agreement with experiments (Saric et al. (1984)) is obtained for low amplitude 2-D Tollmien-Schlichting waves, producing subharmonic breakdown (C- or H-type). For high amplitudes, a mixture of subharmonic and fundamental structures is observed. Clear-cut fundamental breakdown (K-type) is never obtained. In the simulation of the early stages of natural transition in a decelerating boundary layer, 2-D and/or slightly oblique waves initially grow due to the inflectional instability. When they become strong enough, they initiate a secondary instability leading to 3-D distortion and A vortices, in good agreement with experiments (Gad-el-Hak et al. (1984)). It was found that the tips of the A vortices are rarely aligned with the flow direction, and that they appear locally in space. A simple wave interference model accounting for these features of natural transition was developed. It suggests that multiple waves are active in the secondary instability, and that they are determined by unpredictable initial disturbances. The later stages of transition in a decelerating boundary layer were also studied with higher numerical resolution. Our results indicate that the naturally-born A vortices undergo breakdown processes similar to those of ribbon-induced A vortices. Conversely, this justifies the conventional approach to study laminar-turbulent transition, the vibrating-ribbon technique.
Dissert. Abstr.

N90-18002 Minnesota Univ., Minneapolis.
TURBULENT BOUNDARY LAYER PRESSURE FIELD-INDUCED VIBRATIONS IN A THIN FLEXIBLE PLATE UNDER WATER Ph.D. Thesis
Nilabh Narayan 1989 201 p
Avail: Univ. Microfilms Order No. DA8925549

Two point turbulent boundary layer pressure spectra at the wall were determined empirically in a low noise water tunnel. The measured pressure spectra were used in a linear theory to predict the response of a thin stainless steel rectangular plate attached to the water tunnel. The predicted responses were found to agree well with the measured responses of the plate. The in-situ plate response characteristics were also determined empirically by driving the plate separately at several points with a miniature shaker and measuring its response with accelerometers mounted on the plate. The accuracy of the predicted response was found to be controlled by the accuracy of the plate modal model. Due to the reverberant acoustic field in the water tunnel and a complicated supporting structure, the plate modal model could be determined only approximately. The plate modal damping factors were very high, its resonance frequencies were close and the associated mode shapes were complex. These factors made it very difficult to accurately determine the plate modal properties. The wall pressure spectra were also measured for the case when a step discontinuity was present in the wall. These spectra were markedly different from those measured on a smooth wall. Dissert. Abstr.

N90-18003*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
MODELING THE PRESSURE-STRAIN CORRELATION OF TURBULENCE: AN INVARIANT DYNAMICAL SYSTEMS APPROACH Final Report
Charles G. Speziale, Sutanu Sarkar (Institute for Computer Applications in Science and Engineering, Hampton, VA.), and Thomas B. Gatski Jan. 1990 53 p Submitted for publication (Contract NAS1-18605)
(NASA-CR-181979; NAS 1.26:181979; ICASE-90-5) Avail: NTIS HC A04/MF A01 CSCL 20D

The modeling of the pressure-strain correlation of turbulence is examined from a basic theoretical standpoint with a view toward developing improved second-order closure models. Invariance considerations along with elementary dynamical systems theory are used in the analysis of the standard hierarchy of closure models. In these commonly used models, the pressure-strain correlation is assumed to be a linear function of the mean velocity gradients with coefficients that depend algebraically on the anisotropy tensor. It is proven that for plane homogeneous turbulent flows the equilibrium structure of this hierarchy of models is encapsulated by a relatively simple model which is only quadratically nonlinear in the anisotropy tensor. This new quadratic model - the SSG model - is shown to outperform the Launder, Reece, and Rodi model (as well as more recent models that have a considerably more complex nonlinear structure) in a variety of homogeneous turbulent flows. Some deficiencies still remain for the description of rotating turbulent shear flows that are intrinsic to this general hierarchy of models and, hence, cannot be overcome by the mere introduction of more complex nonlinearities. It is thus argued that the recent trend of adding substantially more complex nonlinear terms containing the anisotropy tensor may be of questionable value in the modeling of the pressure-strain correlation. Possible alternative approaches are discussed briefly. Author

N90-18004# Naval Postgraduate School, Monterey, CA.
TURBULENCE STRUCTURE RESULTING FROM INTERACTION BETWEEN AN EMBEDDED VORTEX AND WALL JET M.S. Thesis
James G. Green Jun. 1989 230 p LIMITED REPRODUCIBILITY: Availability: Document partially illegible
(AD-A215702) Avail: NTIS HC A11/MF A02 CSCL 20/4

Interactions of wall jets and vortices embedded in turbulent boundary layers commonly occur near gas turbine blades and endwalls where film cooling is employed. These interactions frequently result in undesirable heat transfer effects at blade and endwall surfaces. In this research, a crossed hot-wire probe is used to measure the turbulence structure resulting from this type of interaction. The vortex is generated using a half-delta-wing vortex generator mounted at 12 degrees with respect to a 10 m/s mean velocity flow over a flat plate. A single injection hole, .95 cm in diameter, inclined 30 degrees to the horizontal, is located under the vortex downwash, 58 cm downstream from the vortex generator. Baseline measurements were made at one streamwise location downstream of the injection hole for the cases: (1) boundary layer only; (2) boundary layer with vortex; and (3) boundary layer with wall jet. Measurement of the interaction between the boundary layer, vortex and 2.5 blowing ratio wall jet was also made at this location. The 1.5 blowing ratio wall jet interaction was measured at three additional streamwise locations. Reynolds stress tensor components, vorticity distributions and mean velocities show that the vortex significantly alters the turbulence structure of the 1.5 blowing ratio wall jet at all four streamwise locations. Here the injectant is swept away from the injection hole by the vortex rotation. GRA

N90-18005*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
RESPONSE OF A CHEMICALLY REACTING LAYER TO STREAMWISE VORTICITY
Russell W. Claus Dec. 1989 12 p Previously announced in IAA as A89-40400

(NASA-TM-102288; E-4956; NAS 1.15:102288) Avail: NTIS HC A03/MF A01 CSCL 20D

A series of Direct Numerical Simulations of a temporally evolving shear layer subject to both harmonic (2D) and streamwise (3D) forcing were performed. The interaction and coupling of these various 2D and 3D modes is shown to significantly alter the development of the flow. The scale of the 3D modes is quite important to the coupling process with greatly enhanced mixing and product formation resulting from 3D modes that are rapidly amplified by the spanwise vorticity. In general, the longer wavelength 3D modes are found to be highly efficient at increasing the momentum transport while the shorter wavelengths increase mass transport. Author

N90-18006# National Aerospace Lab., Tokyo (Japan). Aircraft Aerodynamics Div.

APPLICATION OF JAMESON'S TYPE NONLINEAR ARTIFICIAL DISSIPATION TO THE TWO-DIMENSIONAL NAVIER-STOKES COMPUTATION

Nobuhiro Kawai Feb. 1989 33 p
(NAL-TR-1015T; ISSN-0389-4010) Avail: NTIS HC A03/MF A01

Jameson's nonlinear artificial dissipation model was studied so that the combination and modification of Jameson's type artificial dissipation model and Steger's model could be applied to Beam-Warming-Steger's implicit approximate factorization scheme for the Navier-Stokes equations. Stability analysis is described for the algorithm where the combination of the explicit second-difference and fourth-difference artificial dissipation terms are added to the right-hand side and the implicit second-difference dissipation term is added to the left-hand side so that the system of equations can result in block tri-diagonal equations instead of penta-diagonal equations. The details of the formulation of the artificial dissipation models, including the boundary approximation of the artificial dissipation, are described. Numerical computations were made for transonic and low-speed flows, and the results show that the present formulation is appropriate. The effects of the artificial dissipation models are evaluated. Author

N90-18007# Finnish Meteorological Inst., Helsinki. Air Quality Dept.

A MODEL FOR EVAPORATION OF FREELY FALLING DROPLETS

Timo Vesala, Jaakko Kukkonen, and Markku Kulmala 1989 59 p
(Publ-Air-Quality-6; ISBN-951-697-305-1; ISSN-0782-6095) Avail: NTIS HC A04/MF A01

Results of theoretical investigations concerning the quasi-stationary evaportion of freely falling droplets in the continuum regime are presented. The mathematical model is based on simultaneous numerical solution of equations governing mass and heat transfer from the droplet surface. The model includes a description of forced convective mass and heat transfer due to free fall. The effect of the competing evaporation and settling processes on the deposition of a population of monodisperse droplets is estimated. The model was applied to predict the evolution of water and ammonia droplets in gas mixtures containing air and the vapor of evaporating species. The ambient conditions for the computations were chosen to correspond to accidental releases of liquefied ammonia from pressurized containers. The numerical results show droplet size regimes where deposition or total evaporation take place in various conditions. The model computations give predictions of the mass fraction of species deposited on the ground. Author

N90-18008# California Univ., Berkeley. Dept. of Mechanical Engineering.

NUMERICAL SIMULATION OF UNSTABLY STRATIFIED SHEARED FLOWS Ph.D. Thesis

Sinh-Luh Yuan 1988 370 p
(Contract DE-FG03-85ER-13397)
(DE90-005396; DOE/ER-13397/1) Avail: NTIS HC A16/MF A02

A numerical investigation was performed of three-dimensional instabilities arising in unstably stratified sheared flows. The numerical code developed for the study is the REBUFFS3D (RECirculating BUoyant and Forced Flow Solver-3D) code. It is an extension of the earlier well-tested REBUFFS code developed in Berkeley and includes the improvements embodied in the later Stanford version of the code, REMIXCS (RECirculation MIXed Convection Simulator). Two flow configurations were investigated. In the first, the instabilities are induced by injecting a layer of low density fluid into a co-flowing heavier fluid; in the second, the instabilities are induced by the unstable stratification resulting from the collision of two opposing buoyancy-driven boundary layers moving along a vertical wall. As observed in the experiments for each problem, longitudinal vortices are induced by the buoyancy, the wavelength and stability of which depend on the shear imposed. In the first case, a shear-induced instability appears in addition to the buoyant, which also agrees with the experiment. DOE

N90-18009# California Univ., Berkeley.

COLLIDING NATURAL CONVECTION BOUNDARY LAYER FLOW IN A RECTANGULAR ENCLOSURE Ph.D. Thesis

Weigung Wang 22 Nov. 1989 172 p
(Contract DE-FG03-85ER-13397)
(DE90-005397; DOE/ER-13397/2) Avail: NTIS HC A09/MF A01

The colliding boundary layers problem through buoyant effects was first investigated by Eichhorn and Flicker (1962) and subsequently by Humphrey and Bleinc (1985). A sketch of the configuration of this problem is presented. A vertical wall of a rectangular enclosure is divided into two symmetrical half-sections serving as conducting surfaces. The top, bottom, and the rest of vertical walls of enclosure are insulated. The upper half-section of the conducting wall is kept at a temperature (Tc), which is colder than the ambient fluid, while the lower half-section is kept at a temperature T(sub h), which is hotter than the ambient fluid. Accordingly, the density differences induced by the respective half-sections generate a pair of natural convection boundary layers directed toward each other. DOE

N90-18010# Japan Atomic Energy Research Inst., Tokyo. Dept. of Reactor Safety Research.

THE EFFECT OF THE VIRTUAL MASS FORCE TERM ON THE STABILITY OF TRANSIENT TWO-PHASE FLOW ANALYSIS

Tadashi Watanabe, Masashi Hirano, and Fumiya Tanabe Aug. 1989 24 p
(DE90-733142; JAERI-M-89-101) Avail: NTIS (US Sales Only) HC A03/MF A01

The effect of the virtual mass force term on the stability of transient two-phase flow analysis is studied. The objective form of the virtual mass acceleration is used. The virtual mass coefficient is determined from the stability condition of basic equations against infinitesimal high wave-number perturbations. The parameter is chosen so that a reasonable agreement between the analytical and experimental sound speed in two-phase flows can be obtained. A one-dimensional sedimentation problem is simulated by the MINCS code which is a tool for transient two-phase flow analysis. The stability analysis is performed for the numerical procedure. It is shown that calculated results are stabilized so long as the virtual mass coefficient satisfies the stability condition of differential equations. DOE

N90-18011# California Inst. of Tech., Pasadena. Flight Sciences Lab.

EFFECTS OF CONTROLLED THREE-DIMENSIONAL PERTURBATIONS ON BOUNDARY LAYER TRANSITION Ph.D. Thesis

Steven Philip Schneider 10 Mar. 1989 203 p
(Contracts N00014-87-K-0100; N00014-85-K-0205)
(AD-A215080) Avail: NTIS HC A10/MF A02 CSCL 20/4

The laminar-turbulent transition in a flat plate boundary layer was studied experimentally using a spanwise array of computer-controlled surface heating elements to introduce disturbances at a point just downstream of the critical Reynolds

number. Measurements were made using flush-mounted hot-film wall shear sensors, and the later stages of transition were visualized using dye injection. Measurements of oblique waves in the linear region yielded phase speeds and wave angles that were consistent with the linear theory. In the nonlinear region, the amplitude of subharmonic waves decreased abruptly with increasing oblique-wave angle, so that an oblique wave of about 10 degrees had a subharmonic amplitude which was an order of magnitude below that for a 2D wave. A simple explanation of this behavior is given, in terms of the wave-interaction theory. The intermittency, was measured to determine the relative location of transition. The introduction of a 2D wave is most effective in moving the transition point upstream for a given power input. GRA

N90-18012 California Univ., Los Angeles.
LIQUID TRANSVERSE JETS IN COMPRESSIBLE CROSSFLOWS Ph.D. Thesis
Trinh The Nguyen 1989 222 p
Avail: Univ. Microfilms Order No. DA8926448

A numerical/analytical model is described which predicts the behavior of the non-reacting and the reacting liquid jet in a compressible flow (both supersonic and subsonic). The compressible flowfield about the elliptical jet cross-section is solved at various locations along the jet trajectory by analytical means for M infinity less than or equal to 0.3 and numerical means for M infinity greater than 0.3. External and internal boundary layers along the jet cross-section is calculated and used to determine the jet trajectory by a balance between aerodynamic drag and centripetal forces resulting from jet deflection. The mass loss due to boundary layer shedding and due to evaporation are calculated and incorporated into the trajectory calculation and comparison with experimental observations is made. For supersonic crossflows, the bow shock shape is predicted as well. The presence of a diffusion flame for M infinity less than or equal to 0.3 is also studied, and its effect on mass loss from the fuel jet and on the trajectory shape is explored. Author

N90-18013 California Univ., Los Angeles.
HYDRIDE HEAT PUMPS FOR UPGRADING SPACECRAFT WASTE HEAT Ph.D. Thesis
Hae-Jin Choi 1989 193 p
Avail: Univ. Microfilms Order No. DA8926442

A thermodynamic study of metal hydride heat pumps for upgrading spacecraft waste heat was performed to choose suitable hydride pairs, and to estimate the system efficiency. Heat and mass transfer in a metal hydride bed was modeled. The model includes heat conduction, hydrogen flow governed by Darcy's law modified for the transitional flow regime, and sorption kinetics assuming that diffusion across the hydride is the rate limiting step. The model parameters were established for LaNi4.7Al0.3 alloy using available experimental data. Optimum bed thickness appear to be in the range 10 to approximately 15 mm. A numerical simulation has been made for the dynamic response of the two coupled hydride beds. The Mg2.4Ni/LaNi4.9Al0.1 pair was chosen for the parametric calculations to determine optimal cycle times. An optimal cycle time exists in the range 10 to approximately 12 minutes. Use of hydride heat pumps show merit only in the case of high sink temperatures, above 220 K, and when using hardened radiators. Author

N90-18014# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
FLUID TRANSMISSION LINE DYNAMICS FOR SIGNALS OF FINITE AMPLITUDE Ph.D. Thesis
Wayne P. Chepren Dec. 1989 280 p
(AD-A215758; AFIT/DS/ENY/89-2) Avail: NTIS HC A13/MF A01 CSCL 20/4

The transient response of a straight, cylindrical, fluid transmission line to a finite-amplitude pressure input is studied numerically to identify deviations from linear behavior. A nonlinear, finite-difference method is developed to predict the changes in the shape of a pressure wave as it propagates. The finite-difference algorithm is also applied to a linearized version of the governing equations to generate a basis against which to identify nonlinear behavior. The finite-difference method accounts for viscous losses and heat transfer. An algebraic model for calculating eddy-viscosity in transient, turbulent flows is included. Numerical simulations of a semi-infinite transmission line are performed using trapezoidal and half-sinusoidal pulses as well as a terminated-ramp as input pressure signal waveforms. Significant differences between linear and nonlinear results are found, even for input signals with maximum pressures less than two percent of the initial, undisturbed pressure. GRA

N90-18015# Iowa Univ., Iowa City. Inst. of Hydraulic Research.
OBLIQUE IMPACT OF TWO CYLINDERS IN A UNIFORM FLOW Technical Report, 1 Feb. - 31 Oct. 1989
Zhi Guo and Allen T. Chwang Oct. 1989 43 p
(Contract N00014-89-J-1581)
(AD-A215933; IIHR-333) Avail: NTIS HC A03/MF A01 CSCL 20/4

The oblique motion of a circular cylinder through an inviscid and incompressible fluid, conveyed by a uniform flow at infinity, in the vicinity of another cylinder fixed in space is considered. In a relative polar coordinate system moving with the stream, the kinetic energy of the fluid is expressed as a function of six added masses due to motions parallel and perpendicular to the line joining the centers of the cylinder pair. The Lagrange's equations of motion are then integrated for the trajectories of the moving cylinder. To evaluate the added masses and their derivatives with respect to the separation distance between the cylinders in terms of the hydrodynamic singularities, the method of successive images and the Taylor's added-mass formula are applied, and analytic solutions in closed form are obtained thereafter. The dynamic behavior of a drifting body in the close proximity of a fixed one is investigated by considering the limiting values of the fluid kinetic energy and the interaction forces on each body. The reliability of the numerical approximation of added masses and their derivatives is also discussed in the present study. The integral equations, in terms of surface source distributions and their derivatives on both circles, are carefully modified for obtaining accurate numerical solutions. GRA

N90-18016# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
MODELING THE WAKE AS A CONTINUOUS VORTEX SHEET IN A POTENTIAL-FLOW SOLUTION USING VORTEX PANELS M.S. Thesis
Robert J. Papka Dec. 1989 96 p
(AD-A216220; AFIT/GAE/ENY/89D-26) Avail: NTIS HC A05/MF A01 CSCL 20/4

An investigation was made to determine the advantages of modeling the wake as a continuous vortex sheet in an unsteady potential-flow computer model. The existing program modeled the body as a continuous vortex sheet, and modeled the wake as discrete vortex cores employing principles of vortex lattice methods. A method is developed to approximate the wake with triangular vortex panels. The method accounts for redistributing vortex strength as the panels expand and deform. Comparisons are made with results of the original program for a rectangular wing at varying angles of attack. Limited results suggest the method is valid, and areas for further study are recommended. GRA

N90-18017# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
NUMERICAL SIMULATION OF COMPRESSIBLE VORTICES M.S. Thesis
Scott Andrew Morton Dec. 1989 61 p
(AD-A216221; AFIT/GAE/ENY/89D-24) Avail: NTIS HC A04/MF A01 CSCL 20/4

A delta wing at a high angle of attack produces two vortices that generally undergo dramatic increases in core size, followed by the formation of regions of reversed flow. This phenomenon is called vortex breakdown and can have significant effects on the aircraft's lift, drag, and moment coefficients. The objective of this thesis is to provide a base line model of the compressible vortex,

independent of the complex body interaction with the delta wing. The mathematical model is then used to simulate vortex breakdown for various vortex strengths, Reynolds numbers, and Mach numbers with particular attention given to the effects of compressibility. After running many simulations it was found that Mach number has a favorable effect by delaying vortex breakdown as defined above. Holding Reynolds number and vortex strength constant while increasing Mach number reduced the effective vortex strength while compressing the flow. Another important result of this compressible flow study was the disappearance of non-unique solutions at Re = 200 and V = 1.0 as Mach number was increased. No paths of non-unique solutions were found for M greater than 0.2. GRA

N90-18018# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
INCOMPRESSIBLE FLOW FRICTION FACTORS IN A SIMULATED HEAT PIPE M.S. Thesis
James E. Mayhew Dec. 1989 70 p
(AD-A216288; AFIT/GAE/ENY/89D-23) Avail: NTIS HC A04/MF A01 CSCL 20/4

Porous pipes with blowing and suction are used to simulate the vapor flow in heat pipes. A computer program for steady, 2-D, boundary layer flow was written to find friction factors using the axial pressure distributions measured in an experiment with incompressible flow in a porous pipe. The results for some existing experimental data are presented and compared to previously published solutions for fully-developed flow. Also, this program was modified to numerically simulate porous pipe flow without using axial pressure distribution as an input. This simulation program furnishes additional results for comparison to the original data reduction program. It is observed that the simulation program accurately computes friction factors and flow separation points in a porous pipe with low radial Reynolds number. GRA

N90-18019# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
INVESTIGATION OF HEAT TRANSFER WITH FILM COOLING TO A FLAT PLATE IN A SHOCK TUBE M.S. Thesis
Scott A. Jurgelewicz Dec. 1989 166 p
(AD-A216379; AFIT/GAE/ENY/89D-17) Avail: NTIS HC A08/MF A01 CSCL 20/13

The heat transfer occurring through turbulent boundary layers in modern gas turbines is not well understood. The heat transferred to a flat plate though a turbulent boundary layer presents many similarities without the complex flow patterns. The gas used in this study was air. The flow behind a passing shock wave in a shock tube was used to simulate the high temperature ratio flows found in gas turbines. Highly responsive heat flux gages were used to measure the temperature history of a flat plate exposed to the flow. High speed digital recorders were used to sample and store the information. Heat transfer rates were determined from temperature history using a computer program and a quadrature method. The temperature history was numerically averaged to filter out noise effects before it was used to calculate the heat flux. It was found that low shock Mach numbers produced measured heat flux rates that were predictable by theory. At higher Mach numbers the rounded leading edge of the plate produced reflections that increased the measured heat flux as the Mach number increased; but theory, dependent on incident shock Mach number, underpredicted these actual values. Film cooling flows were then studied under the same flow conditions. Ratios of heat transfer coefficients with blowing ratios of approximately two to three produced the best agreement with correlations. The effects of free stream turbulence on the heat flux with film cooling were also briefly studied. GRA

N90-18020# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
FLUCTUATING WIND FORCES MEASURED ON A BLUFF BODY EXTENDING FROM A CAVITY M.S. Thesis
Brian W. King Dec. 1989 198 p
(AD-A216414; AFIT/GAE/ENY/89D-19) Avail: NTIS HC A09/MF A01 CSCL 20/4

The effect of wind forces measured on a bluff body extending from a cavity was investigated. This was accomplished by measuring wind induced vibratory inputs to a plexiglas bluff body model. The model extended from a ground board cavity installed in the AFIT 5-Foot Wind Tunnel. Forces and moments were measured from an 8 element load cell unit built and installed in the base of a plexiglas model. Three different size cavity openings were tested for both a no-rotation and 45 degree rotation referenced to the wind. Data was taken at individual speed points between 55 ft/s and 180 ft/s, producing Reynolds number based on model width in the range of 1.5 x 10 to the 5th power to 5.0 x 10 to the 5th power. Baseline data for a closed cavity configuration was collected and compared to previous studies conducted at the USAF Academy. Force and moment coefficient data are presented, comparing cavity opening and model rotation effects. Results of shedding frequency analysis are presented based on transient data recorded. GRA

N90-18021# Lawrence Livermore National Lab., CA. Center for Compressible Turbulence.
COMPUTING SHOCK WAVES IN TURBULENT MIXING REGIONS
Alfred C. Buckingham Nov. 1989 6 p Presented at the 7th Biennial Nuclear Explosives Design Physics Conference, Livermore, CA, 16-20 Oct. 1989
(Contract W-7405-eng-48)
(DE90-005996; UCRL-102305; CONF-8910226-1) Avail: NTIS HC A02/MF A01

This concerns the observed random changes to shock transitional velocity, density, and temperature induced when shocks interact with turbulence. This interaction may be useful as a diagnostic for ascertaining the distribution of interaction energy between competitive acoustic, entropy and vortical modes. Numerical procedures are used here to supplement physical experiments. The results are obtained from use of an ALE finite-difference code method with viscoelasticity (SHALE), a hybrid Euler/Lagrange pseudospectral method, and a Monte Carlo random-choice procedure. The latter magnifies the shock front transition region generating PDF-transition profiles. DOE

N90-18022# Lawrence Livermore National Lab., CA.
A NUMERICAL STUDY OF SHOCK WAVE REFRACTION AT A CO2/CH4 INTERFACE
Elbridge Gerry Puckett 11 Dec. 1989 23 p Presented at the Workshop on Multi-dimensional Hyperbolic Problems and Computations, Minneapolis, MN, 3-14 Apr. 1989
(Contracts W-7405-eng-48; IACRO-88-873)
(DE90-005997; UCRL-102420; CONF-8904308-1) Avail: NTIS HC A03/MF A01

This paper describes the numerical computation of a shock wave refracting at a gas interface. We study a plane shock in carbon dioxide striking a plane gas interface between the carbon dioxide and methane at angle of incidence. The primary focus here is the structure of the wave system as a function of the angle of incidence for a fixed (weak) incident shock strength. The computational results agree well with the shock polar theory for regular refraction including accurately predicting the transition between a reflected expansion and a reflected shock. They also yield a detailed picture of the transition from regular to irregular refraction and the development of a precursor wave system. In particular, the computations indicate that for the specific case studied the precursor shock weakens to become a band of compression waves as the angle of incidence increases in the irregular regime. DOE

35 INSTRUMENTATION AND PHOTOGRAPHY

Includes remote sensors; measuring instruments and gages; detectors; cameras and photographic supplies; and holography.

For aerial photography see *43 Earth Resources and Remote Sensing*. For related information see also *06 Aircraft Instrumentation*, and *19 Spacecraft Instrumentation*.

N90-18023# Johns Hopkins Univ., Baltimore, MD. Dept. of Materials Science and Engineering.
FULL FIELD VISUALIZATION OF SURFACE AND BULK ACOUSTIC WAVES USING HETERODYNE HOLOGRAPHIC INTERFEROMETRY Annual Summary Report, 1 Jan. 1988 - 30 Sep. 1989
James W. Wagner and Robert E. Green, Jr. 15 Sep. 1989 8 p
(Contract N00014-82-K-0741)
(AD-A214353) Avail: NTIS HC A02/MF A01 CSCL 09/4

Optical holographic techniques were coupled with electronic signal and image processing to provide quantitative, full field measurements of acoustic wave disturbances. This program has sought to establish the limits of sensitivity with which surface acoustic waves might be measured and mapped. In addition, significant progress was made toward extending heterodyne holographic measurements to the examination of acoustic energy flow by mapping refractive index changes in optically transparent bulk materials. To date a holographic based optical tomography method was demonstrated which maps slowly varying changes in refractive index caused by heat flow in a rigid polymer. The extension of this method to permit 3-D mapping of acoustic energy flow was studied. GRA

N90-18024# Swedish Inst. for Materials Testing, Boras.
INSTRUMENTATION OF PENDULUM IMPACTOR USING METAL FOIL STRAIN GAUGES
Magnus Holmgren and Ulf Olofsson 1989 21 p
(PB90-122656; SP-RAPP-1989:10; ISBN-91-7848-159-7; ISSN-0284-5172) Avail: NTIS HC A03/MF A01 CSCL 14B

Two pendulum impactors (150 J and 14.7 J) were instrumented with foil strain gauges. The tup belonging to the smaller impactor was weakened in order to increase the level of the strain signal from the gauges. The instrumented tups were statistically calibrated and utilized for impact testing of different materials. It was concluded that although it is possible to use metal foil strain gauges, semiconductor gauges are the best choice in most applications due to their high gauge factors. GRA

N90-18025*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
LASER DIFFRACTION PARTICLE SIZING: INSTRUMENT PROBE VOLUME RELOCATION AND ELONGATION
Robert C. Anderson, Donald R. Buchele, Edward A. Hovenac, and James A. Lock (Cleveland State Univ., OH.) 1990 12 p Presented at the 2nd International Congress on Optical Particle Sizing, Tempe, AZ, 5-8 Mar. 1990; sponsored by Arizona State Univ.
(NASA-TM-102512; E-5315; NAS 1.15:102512) Avail: NTIS HC A03/MF A01 CSCL 14B

The effective probe volume of laser diffraction particle sizing instruments depends on many instrument parameters. In particular the probe volume axial boundaries and its location along laser beam are essentially defined by the onset of a vignetting effect where light scattered at large angles from small particles misses the transform lens. This vignetting effect results in a probe volume that must be inconveniently close to the lens in order to detect smaller diameter particles (less than 100 micrometers). With the addition of an appropriately designed Keplerian telescope, the probe volume may be relocated and elongated. The theory of operation of this supplemental optical system is described. Design considerations for these supplemental optical systems are described, including recommendations for lens specifications, assembly and use. An image transfer system is described which has been designed for use on a Malvern 2600HSD instrument. Experimental validation of this image transfer system is described. Author

N90-18026# Lawrence Livermore National Lab., CA.
DESIGN OF A MICROWAVE CALORIMETER FOR THE MICROWAVE TOKAMAK EXPERIMENT
Marty Marinak (California Univ., Berkeley.) 7 Oct. 1988 37 p
(Contract W-7405-eng-48)
(DE90-004486; UCID-21808) Avail: NTIS HC A03/MF A01

The initial design of a microwave calorimeter for the Microwave Tokamak Experiment is presented. The design is optimized to measure the refraction and absorption of millimeter RF microwaves as they traverse the toroidal plasma of the Alcator C tokamak. Techniques utilized can be adapted for use in measuring high intensity pulsed output from a microwave device in an environment of ultra high vacuum, intense fields of ionizing and non-ionizing radiation and intense magnetic fields. DOE

N90-18027# Sandia National Labs., Albuquerque, NM.
EFFECTIVE WAVEFORM RECORDER EVALUATION PROCEDURES
Philip J. Green 1990 21 p Presented at the IEEE Instrumentation and Measurement Technology, San Jose, CA, 13-15 Feb. 1990
(Contract DE-AC04-76DP-00789)
(DE90-005197; SAND-89-3017C; CONF-900228-2) Avail: NTIS HC A03/MF A01

The evaluation of waveform recorders is a subject attracting considerable attention as waveform recorders continue to increase in capabilities without dramatic increase in costs. However, caution is required when developing evaluation procedures because of the potential of any evaluation procedure to overestimate the performance of a device. A system is described which is controlled by a Microvax II with instrumentation control through the IEEE-488 bus. Evaluation procedures are described with attention given to the pathological cases which can lead to significant misestimates of a digitizer's performance. These evaluation procedures are aimed at being consistent with the new Trial Waveform Digitizer Standard generated by the Waveform Measurements and Analysis committee appointed by the Instrumentation and Measurement Society of IEEE. This standard was recently accepted by the IEEE as a trial use standard through July 1991 and is available from the IEEE Service Center as IEEE Std. 1057. DOE

N90-18028# Argonne National Lab., IL.
L X RAY SPECTROMETRY IN VIVO WITH A Si(Li)-NaI(Tl)
M. G. Strauss, A. T. Keane, S. A. Reinke, and R. H. Pehl (California Univ., Berkeley. Lawrence Berkeley Lab.) 1990 8 p Presented at the Institute for Electronic and Electrical Engineers (IEEE) Nuclear Science Symposium, San Francisco, CA, 22-26 Jan. 1990
(Contract W-31-109-eng-38)
(DE90-005649; CONF-900143-10) Avail: NTIS HC A02/MF A01

A new Si(Li)-NaI(Tl) spectrometer was developed for measurements of UL x rays from Pu-239 in lungs of exposed persons. The spectrometer consists of six large, cooled Si(Li) detectors mounted on edge to provide two windows, one facing the lungs and the other a NaI(Tl) scintillator for anticoincidence background suppression. The sensitive area of the array is 54.5 sq cm and the FWHM resolution at 17 keV is 390 eV. The ambient background count rate per minute in the energy band of interest of the Si(Li)-NaI(Tl) detector is 0.13. This is less than 1/4 of that of an equal area HPGe detector and 1/15 of an equal area phoswich. The sensitivity of this detector for Pu-239 approaches the maximum achievable, where the minimum detectable level is fundamentally limited by the lung geometry (signal) and the natural radioactivity in the human body (background). With this detector one can measure for the first time Pu in human lungs directly even in the presence of Am-241. A spectrum of ZrK x rays from (92m)Nb (simulating Pu), obtained from lungs of a human subject in vivo, demonstrate the detector performance. DOE

N90-18029# Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil). Ministerio da Ciencia e Tecnologia.
FIRST TEST RESULTS WITH A CCD CAMERA DEVELOPED BY INPE
Marcus Antonius AndradeSiqueira, Antonio LopesFilho, Jose DiasdeMatos, and Roberto PereiradaCunha Jul. 1989 11 p Presented at the 3rd Simposio Brasileiro de Sensoriamento Remoto, Rio de Janeiro, Brazil, 28-30 Nov. 1984
(INPE-4873-PRE/1484) Avail: NTIS HC A03/MF A01

The Instituto de Pesquisas Espaciais (INPE) (Brazilian Space Research Center) developed a prototype of an airborne opto-electronic camera for multispectral imaging. This camera is based entirely on solid-state principles and the earth's surface is imaged by continuously scanning lines which are normal to the flight direction. A self-scanning, high resolution charge-coupled device (CCD) linear array serves as the sensor. The Brazilian Bandeirante aircraft was used for a test flight. The images produced by the camera were quite satisfactory. Author

N90-18030# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
ANALYSIS AND TEST OF A WIDE ANGLE SPECTROMETER M.S. Thesis
Robert D. Kaiser Dec. 1989 94 p
(AD-A215819; AFIT/GEP/ENP/89D-6) Avail: NTIS HC A05/MF A01 CSCL 15/3

An analysis and test of a design for a laser warning receiver which provides aircrew warning and collects threat data is described. The analysis and test includes the optics and detector of the system. A design for a device to measure wavelength, angle of arrival, and energy of a laser pulse is analyzed and tested. The instrument has a 180 degree field of view and an operating range of 400 nm to 800 nm. In a series of tests the instrument was found to measure angle of arrival accurately to within + or - 41 arc minutes and a wavelength to within 1 nm. A variation of + or - 20 percent in the measurement of pulse energy per unit area was found for small changes in angle of arrival. The system was thermal noise limited and could detect a pulse that was 1/45 of the Maximum Permissible Exposure (MPE) with an uncooled detector. When using a detector cooled to -10 C, the system could detect a pulse 1/22000 of the MPE. This research is an attempt to design, analyze, prototype, and test an approach to meeting this need which uses a cylindrical lens and a spectrometer equipped with an area detector. GRA

N90-18031# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
DEVELOPMENT OF AN ALTERNATIVE CONCENTRATION PROBE CALIBRATION METHOD M.S. Thesis
George Rudolph Stoller, Jr. Dec. 1989 46 p
(AD-A216245; AFIT/GAE/ENY/89D-37) Avail: NTIS HC A03/MF A01 CSCL 14/2

Aspirating, hot wire concentration probes are used to measure point-wise binary species concentrations in supersonic gaseous flow fields. Calibration of such probes is usually carried out by exposing the probe to a known mixture as it discharges from a fixed volume (or tank). A new, steady flow method for the calibration of helium/air concentration probes has been developed and has been compared with an existing tank discharge method. The two calibration curves have been found to be in close agreement, with a difference of 0.05 helium molar fraction between them for given a value of wire heat loss. Probe design is suspected of being responsible for this slight variation in helium molar fraction. Hence, either method can be used for calibration of such probes. GRA

N90-17903*# National Bureau of Standards, Gaithersburg, MD. Radiometric Physics Div.
RADIATION THERMOMETRY AT NIST: AN UPDATE OF SERVICES AND RESEARCH ACTIVITIES
G. Barry Hillard *In* JPL, Proceedings of the Second Noncontact Temperature Measurement Workshop 1 Jun. 1989 p 71-79 (For primary document see N90-17894 10-31)
Avail: NTIS HC A16/MF A03 CSCL 14B

N90-17904*# Honeyhill Technical Co., Norwalk, CT.
INFRARED THERMAL IMAGING FIGURES OF MERIT
Herbert Kaplan *In* JPL, Proceedings of the Second Noncontact Temperature Measurement Workshop 1 Jun. 1989 p 80-89 (For primary document see N90-17894 10-31)
Avail: NTIS HC A16/MF A03 CSCL 14B

N90-17905*# Physical Sciences, Inc., Andover, MA.
A MULTICOLOR IMAGING PYROMETER
Michael B. Frish and Jonathan H. Frank *In* JPL, Proceedings of the Second Noncontact Temperature Measurement Workshop 1 Jun. 1989 p 90-97 (For primary document see N90-17894 10-31)
Avail: NTIS HC A16/MF A03 CSCL 14B

N90-17907*# Intersonics, Inc., Northbrook, IL.
SPECTRAL EMISSIVITIES AND OPTICAL CONSTANTS OF ELECTROMAGNETICALLY LEVITATED LIQUID METALS AS FUNCTIONS OF TEMPERATURE AND WAVELENGTH
S. Krishnan, R. H. Hauge, and J. L. Margrave (Rice Univ., Houston, TX.) *In* JPL, Proceedings of the Second Noncontact Temperature Measurement Workshop 1 Jun. 1989 p 110-140 (For primary document see N90-17894 10-31)
Avail: NTIS HC A16/MF A03 CSCL 14B

N90-17909*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
IR OPTICAL FIBER-BASED NONCONTACT PYROMETER FOR DROP TUBE INSTRUMENTATION
R. G. May, S. Moneyhun, W. Saleh, S. Sudeora, R. O. Claus (Virginia Polytechnic Inst. and State Univ., Blacksburg.), and A. M. Buoncristiani *In* JPL, Proceedings of the Second Noncontact Temperature Measurement Workshop 1 Jun. 1989 p 150-157 (For primary document see N90-17894 10-31)
Avail: NTIS HC A16/MF A03 CSCL 14B

N90-17920*# Honeyhill Technical Co., Norwalk, CT.
AN UPDATE OF COMMERCIAL INFRARED SENSING AND IMAGING INSTRUMENTS
Herbert Kaplan *In* JPL, Proceedings of the Second Noncontact Temperature Measurement Workshop 1 Jun. 1989 p 253-270 (For primary document see N90-17894 10-31)
Avail: NTIS HC A16/MF A03 CSCL 14B

N90-17921*# Barnes Engineering Co., Stamford, CT.
A SPACE QUALIFIED THERMAL IMAGING SYSTEM USING A Pt Si DETECTOR ARRAY
Robert W. Astheimer *In* JPL, Proceedings of the Second Noncontact Temperature Measurement Workshop 1 Jun. 1989 p 271-283 (For primary document see N90-17894 10-31)
Avail: NTIS HC A16/MF A03 CSCL 14B

N90-17922*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
DEVELOPMENT OF AN INFRARED IMAGING SYSTEM FOR THE SURFACE TENSION DRIVEN CONVECTION EXPERIMENT
Alexander D. Pline *In* JPL, Proceedings of the Second Noncontact Temperature Measurement Workshop 1 Jun. 1989 p 284-293 Previously announced as N89-17211 (For primary document see N90-17894 10-31)
Avail: NTIS HC A16/MF A03 CSCL 14B

N90-17923*# Honeyhill Technical Co., Norwalk, CT.
NCTM WORKSHOP SPLINTER SESSION, IR THERMAL MEASUREMENT INSTRUMENTS Abstract Only
Herbert Kaplan *In* JPL, Proceedings of the Second Noncontact Temperature Measurement Workshop 1 Jun. 1989 p 297-298 (For primary document see N90-17894 10-31)
Avail: NTIS HC A16/MF A03 CSCL 14B

N90-17924*# Oak Ridge National Lab., TN.
DYNAMIC RESPONSE FOR THERMAL CONTROL AND MEASUREMENT AND FAST RADIATION THERMOMETRY
R. L. Shepard and A. Cezairliyan (National Bureau of Standards, Gaithersburg, MD.) *In* JPL, Proceedings of the Second Noncontact Temperature Measurement Workshop 1 Jun. 1989 p 299-302 (For primary document see N90-17894 10-31)
Avail: NTIS HC A16/MF A03 CSCL 14B

N90-17926*# Massachusetts Inst. of Tech., Cambridge.
REPORT ON THE MULTICOLOR PYROMETRY SESSION AT THE SECOND NASA NON-CONTACT TEMPERATURE-MEASUREMENT WORKSHOP Abstract Only
R. Erik Spjut *In* JPL, Proceedings of the Second Noncontact Temperature Measurement Workshop 1 Jun. 1989 p 317-318 (For primary document see N90-17894 10-31)
Avail: NTIS HC A16/MF A03 CSCL 14B

36 LASERS AND MASERS

Includes parametric amplifiers.
For related information see also *76 Solid-State Physics.*

N90-18032# United Technologies Optical Systems, Inc., West Palm Beach, FL.
EXPERIMENTAL AND THEORETICAL STUDY OF CO2 STAGGERED HOLLOW-BORE ARRAY LASERS Final Report, 1 Jan. 1988 - 30 Jun. 1989
D. Park, R. A. Hart, and L. A. Newman 20 Aug. 1989 57 p
(Contracts F49620-88-C-0031; F49620-85-C-0109)
(AD-A212921; AFOSR-89-1232TR) Avail: NTIS HC A04/MF A01 CSCL 09/3

Experimental and theoretical investigation of CO2 staggered hollow-bore (SHB) arrays were conducted with the main objective of gaining a better understanding of the device. By focussing on the effects of a mirror tilt on the output power, the near field and pairwise far field patterns, the effective cavity length variations, manifested primarily through mode mismatch loss, it was deduced that they are responsible for many of the observed features of phase locked SHB arrays. It was also found that by making one of the elements very lossy, the entire array can be shut down, which could have a potential application as a novel amplitude modulation technique. GRA

N90-18033# Air Force Systems Command, Wright-Patterson AFB, OH. Foreign Technology Div.
TWO DIMENSIONAL MODIFICATIONS OF GAUSSIAN LASER LIGHT BUNDLES
Xiaojie Zhang, Xiaoyi Dong, and Shouchuen Shen 24 Oct. 1989 17 p Transl. into ENGLISH from Acta Optica Sinica (China), v. 5, no. 8, Aug. 1985 p 709-716
(AD-A215207; FTD-ID(RS)T-0709-89) Avail: NTIS HC A03/MF A01 CSCL 20/6

This presents, under the effects of a two-dimensional standing wave acoustic field, a two-dimensional theory for form modifications in the spacial strengths of Gaussian laser light bundles or beams. The results of experimentation and theory agree with each other. Under the appropriate ultrasonic power, the strength of faculae center domains tends toward uniformity. Moreover, the degree of uniformity and the range of it can be adjusted. Because of this, it has even more practical significance. GRA

N90-18034# Oak Ridge National Lab., TN. Instruments and Controls Div.
DEVELOPMENT OF A SOLAR-POWERED INFRARED INJECTION LASER MICROMINIATURE TRANSMITTING SYSTEM
D. D. Falter, G. T. Alley, K. G. Falter, J. M. Rochelle (Tennessee Univ., Knoxville.), K. H. Valentine, R. D. Westbrook, G. E. Jr. Jellison, and P. H. Fleming 1989 8 p Presented at the International Conference on Lasers '89, New Orleans, LA, 3-8 Dec. 1989
(Contract DE-AC05-84OR-21400)
(DE90-005672; CONF-891261-2) Avail: NTIS HC A02/MF A01

A solar-powered infrared microminiature transmitting system is being developed to provide scientists with a tool to continuously track and study Africanized bees. Present tracking methods have limited ranges and lack the capability of continuously tracking individual insects. Preliminary field tests of a stationary prototypic transmitter have demonstrated a range of 1.1 km. The basic design consists of an array of nine 1-mm(sup 2) solar cells, which collect energy for storage in a 1.0-(mu)F tantalum chip capacitor. When the capacitor has been charged to a sufficient level, the circuitry that monitors the capacitor voltage level wakes up and fires a 5-(mu)s pulse through an 840-nm GaAlAs injection laser diode. The process is then repeated, making the signal frequency (which ranges from 50 to 300 Hz) dependent on solar luminance. The solar cells, capacitor, and laser diode are mounted in hybrid microcircuit fashion directly on the silicon substrate containing the CMOS control and driver circuitry. The transmitter measures approximately 4 times 6 mm and weighs approximately 65 mg. The receiving system is based on an 8-in. telescope and a Si PIN diode detector. DOE

N90-18035# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
NUMERIC MODEL OF A CO2 LASER AMPLIFIER M.S. Thesis
Frank P. Gallagher Dec. 1989 83 p
(AD-A215818; AFIT/GSO/ENP/89D-2) Avail: NTIS HC A05/MF A01 CSCL 09/3

A carbon dioxide laser amplifier simulation model is developed for use on IBM-compatible personal computers. First, a general laser amplifier is modeled by dividing an amplifier into separate cells to model both the temporal and spatial dependence of the amplifier's gain. The resulting amplification is validated by comparison with a closed-form solution. Second, losses due to amplified spontaneous emissions (ASE) are investigated and included in the model. Equations for ASE losses consider both the solid angle of the emissions and the reflectivity of the cavity windows. Other reflections are ignored. Third, an existing numerical model of CO2 gas kinetics is incorporated. In this kinetics model, temperature-dependent terms are fixed according to initial conditions, and the rotational levels of the upper CO2 vibrational state are assumed to be in equilibrium. The user-friendly model allows designers and students to investigate the amplification of either square input pulses or pulses generated with a laser oscillator while varying several input parameters. Among the variable parameters are length, diameter, gas mix, temperature, pressure, window reflectivity, and pump efficiency. GRA

N90-18036# Massachusetts Inst. of Tech., Lexington. Lincoln Lab.
LASER INTERSATELLITE TRANSMISSION EXPERIMENT SPATIAL ACQUISITION, TRACKING, AND POINTING SYSTEM
John E. Kaufmann and Eric A. Swanson 12 Sep. 1989 107 p
(Contract F19628-85-C-0002)
(AD-A215934; SC-80; ESD-TR-89-158) Avail: NTIS HC A06/MF A01 CSCL 25/5

The spatial acquisition, tracking, and pointing system of the MIT Lincoln Laboratory Laser Intersatellite Transmission Experiment (LITE) flight package which was to be integrated on the NASA Advanced Communication Technology Satellite (ACTS) is described. The overall design approach and underlying rationale are also discussed. Considerable attention is given to the characterization of the spacecraft's dynamic environment and its impact on acquisition and tracking subsystem design and performance. GRA

N90-18037# Texas Univ., Dallas. Center for Quantum Electronics.
THE GAMMA-RAY LASER PROJECT: PROOF OF THE FEASIBILITY OF COHERENT AND INCOHERENT SCHEMES FOR PUMPING A GAMMA-RAY LASER Quarterly Progress Report, 1 Jul. - 30 Sep. 1989

Carl B. Collins Oct. 1989 55 p
(Contract N00014-86-C-2488)
(AD-A216008; UTD-GRL/8902) Avail: NTIS HC A04/MF A01 CSCL 09/3

Recent approaches to the problem of the gamma-ray laser have focused upon upconversion techniques in which metastable nuclei are pumped with long wavelength radiation. At the nuclear level the storage of energy can approach tera-Joules per liter for thousands of years. However, any plan to use such a resource for a gamma-ray laser poses problems of a broad interdisciplinary nature requiring the fusion of concepts taken from an relatively unrelated field of physics. Our research group has described several means through which this energy might be coupled to the radiation fields with cross sections for stimulated emission that could reach 10 to the minus 17th power sq cm. Such a stimulated release could lead to output powers as great as 3 x 10 to the 21st power Watts/liter. Since 1978 we have pursued an approach for the upconversion of longer wavelength radiation incident upon isomeric nuclear populations that can avoid many of the difficulties encountered with traditional concepts of single photon pumping. Recent experiments have confirmed the general theory and have indicated that a gamma-ray laser is feasible if the right combination of energy levels and branching ratios exists in some real material. Of the 1,886 distinguishable nuclear materials, the present state-of-the-art has been adequate to identify 29 first-class candidates, but further evaluation cannot proceed without remeasurements of nuclear properties with higher precision. GRA

N90-18038# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
EXPERIMENTAL INVESTIGATION OF A CHEMICAL LASER CAVITY FLOWFIELD M.S. Thesis
Stephen Walter Stiglich, Jr. Dec. 1989 122 p
(AD-A216398; AFIT/GAE/ENY/89D-36) Avail: NTIS HC A06/MF A01 CSCL 09/3

Chemical lasers require a cavity that establishes and maintains the proper gas dynamic properties during lasing. The design and performance of a flow system capable of supporting the hypersonic flow conditions in a lasing cavity are described. Using cold air as the working medium, the flow control system configuration and nozzle-cavity-supersonic diffuser assembly configuration were developed to establish acceptable flow conditions in the test section. Performance evaluation was based on pressure measurements in the nozzle-cavity-diffuser assembly and schlieren photographs of the flowfield in the cavity. Flow conditions in the test section were broken up into three different regions: flow in the hypersonic nozzles, flow in the base region and flow in the cavity region. Flow in the nozzles was analyzed using one-dimensional, steady, isentropic flow theory. Test results indicated that the hypersonic nozzles performed to design specifications. The Korst two-dimensional base-pressure flow model was used to describe the flow in the nozzle exit plane and base region. Experimentally calculated Mach numbers and static pressures corresponded very closely to theoretical values. Static pressure ports and schlieren photographs were used to describe the flow-field conditions in the cavity region. GRA

N90-18039# Aerospace Corp., El Segundo, CA. Lab. Operations.
CW (CONTINUOUS WAVE) STIMULATED BRILLOUIN SCATTERING OF LONG-PULSE CHEMICAL LASER BEAMS
S. T. Amimoto and R. Hofland, Jr. 15 Nov. 1989 18 p
(Contract F04701-85-C-0086)
(AD-A216409; TR-0086A(2930-06)1; SSD-TR-89-88) Avail: NTIS HC A02/MF A01 CSCL 09/3

Backward Stimulated Brillouin Scattering (SBS) is currently under consideration as a nonlinear optical process for passive phase conjugation (beam clean up) phase matching (beam combination), and pointing and tracking of continuous-wave (CW) HF chemical lasers for high power applications. Theoretical considerations indicate, however, that forward SBS processes dominate over backward SBS phenomena in the steady-state limit, so that SBS exhibits the desired properties (phase conjugation) only for short time periods. Since backward SBS thresholds for CW HF lasers are about 0.20 MW per spectral line, long-pulse laboratory chemical laser sources (PCLs) are needed to investigate small-angle forward scattering phenomena and the development of techniques for their suppression. The laser data presented herein suggest that a moderate-volume, photolysis-pumped PCL is a suitable source for the study of steady-state forward SBS processes and their suppression. In particular, low pressure PCLs can simulate CW HF-laser SBS behavior under conditions of the proper bandwidth, laser spectrum, SBS media effects, longitudinal mode structure, and other high-power HF laser characteristics. GRA

N90-18040# Lawrence Livermore National Lab., CA.
DIODE PUMPED MONOLITHIC Nd:YLF 1.053 MICRON MINI-LASER AND ITS APPLICATION TO INJECTION SEEDING
Jerome M. Auerbach and Randal L. Schmitt (Sandia National Labs., Albuquerque, NM.) 17 Nov. 1989 10 p Presented at the SPIE Optics, Electro-optics and Laser Applications in Science and Engineering Conference and Exhibition, Los Angeles, CA, 20-25 Jan. 1990
(Contracts W-7405-eng-48; DE-AC04-76DP-00789)
(DE90-005323; UCRL-102308; CONF-900140-3) Avail: NTIS HC A02/MF A01

The construction and operation of a diode-pumped Nd:YLF monolithic mini-laser operating at 1.053 (mu)m is described along with its application of injection seeding a CW flashlamp Nd:YLF Q-switched oscillator to produce single frequency pulses. Alignment of the mini-laser axis to the c axis of the Nd:YLF crystal allows lasing at 1.053 (mu)m in a monolithic configuration. The Q-switched oscillator when seeded produces single frequency pulses 90 percent of the time. DOE

N90-17901*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
SOLID STATE LASERS FOR USE IN NON-CONTACT TEMPERATURE MEASUREMENTS
A. M. Buoncristiani *In* JPL, Proceedings of the Second Noncontact Temperature Measurement Workshop 1 Jun. 1989 p 60-69
(For primary document see N90-17894 10-31)
Avail: NTIS HC A16/MF A03 CSCL 20E

37 MECHANICAL ENGINEERING

Includes auxiliary systems (nonpower); machine elements and processes; and mechanical equipment.

N90-18041*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
GEAR NOISE, VIBRATION, AND DIAGNOSTIC STUDIES AT NASA LEWIS RESEARCH CENTER
James J. Zakrajsek, Fred B. Oswald, Dennis P. Townsend, and John J. Coy 1990 10 p Prepared for presentation at the 1st International Conference on Gear Box Noise and Vibration, Cambridge, England, 10-11 Apr. 1990; sponsored by the Institution of Mechanical Engineers
(DA Proj. 1L1-62209-A4-7A)
(NASA-TM-102435; E-5204; NAS 1.15:102435; AVSCOM-TR-89-C-020) Avail: NTIS HC A02/MF A01 CSCL 13I

The NASA Lewis Research Center and the U.S. Army Aviation Systems Command are involved in a joint research program to advance the technology of rotorcraft transmissions. This program consists of analytical as well as experimental efforts to achieve the overall goals of reducing weight, noise, and vibration, while increasing life and reliability. Recent analytical activities are highlighted in the areas of gear noise, vibration, and diagnostics performed in-house and through NASA and U.S. Army sponsored grants and contracts. These activities include studies of gear tooth profiles to reduce transmission error and vibration as well as gear housing and rotordynamic modeling to reduce structural vibration transmission and noise radiation, and basic research into current

gear failure diagnostic methodologies. Results of these activities are presented along with an overview of near term research plans in the gear noise, vibration, and diagnostics area. Author

N90-18042# National Aerospace Lab., Tokyo (Japan).
EFFICIENCY MEASUREMENT OF HIGH PRESSURE CRYOGENIC ROCKET PUMPS
Yoshiaki Watanabe, Satoshi Hasegawa, and Kenjiro Kamijo 1989 12 p In JAPANESE; ENGLISH summary
(NAL-TR-1022; ISSN-0389-4010) Avail: NTIS HC A03/MF A01

It was required that high pressure cryogenic pump efficiency be measured with great accuracy. If ordinary measurement apparatuses, such as a torque meter, are used, the pump rotor assembly becomes so complicated that the designed rotational speed may not be achieved. In order to solve this problem, research was done on whether the adiabatic efficiency, which has been used with compressors, could be applied to a high pressure cryogenic pump. The adiabatic efficiency is calculated using some enthalpies which are obtained by measuring pressures and temperatures at both pump inlet and outlet. A simple calculation was made in order to compare the ordinary efficiency with the adiabatic efficiency and to show how to correct the adiabatic efficiency. It was shown that the adiabatic efficiency could be experimentally obtained with fairly small uncertanties. Author

N90-18043*# Catholic Univ. of America, Washington, DC. Dept. of Electrical Engineering.
LEARNING-BASED POSITION CONTROL OF A CLOSED-KINEMATIC CHAIN ROBOT END-EFFECTOR
Charles C. Nguyen and Zhen-Lei Zhou Feb. 1990 19 p
(Grant NAG5-780)
(NASA-CR-186283; NAS 1.26:186283) Avail: NTIS HC A03/MF A01 CSCL 13I

A trajectory control scheme whose design is based on learning theory, for a six-degree-of-freedom (DOF) robot end-effector built to study robotic assembly of NASA hardwares in space is presented. The control scheme consists of two control systems: the feedback control system and the learning control system. The feedback control system is designed using the concept of linearization about a selected operating point, and the method of pole placement so that the closed-loop linearized system is stabilized. The learning control scheme consisting of PD-type learning controllers, provides additional inputs to improve the end-effector performance after each trial. Experimental studies performed on a 2 DOF end-effector built at CUA, for three tracking cases show that actual trajectories approach desired trajectories as the number of trials increases. The tracking errors are substantially reduced after only five trials. Author

N90-18044# Argonne National Lab., IL.
COMPARISON OF EMISSIONS OF TRANSIT BUSES USING METHANOL AND DIESEL FUEL
John B. Rajan and Danilo J. Santini 1989 33 p Presented at the Transportation Research Board Meeting on Improved Policies and Methods to Solve Air Quality Problems, Washington, DC, Jan. 1990
(Contract W-31-109-eng-38)
(DE90-005652; CONF-900121-5) Avail: NTIS HC A03/MF A01

This paper provides a summary review of several comparative studies on the emission characteristics of methanol- and diesel-fueled buses. In order to facilitate comparison, the emissions data at idle and various driving cycles are presented on an hourly and/or per-mile basis. The results suggest that the substitution of methanol-fueled buses for clean diesel buses is not likely to result in net air-quality improvements during low-speed operations in an urban environment. Under these conditions, the negative effects of increases in carbon monoxide, formaldehyde, and hydrocarbons may offset the positive effects of particulate emissions reduction. However, for higher average driving speeds, the results to date are more promising, suggesting that methanol-fueled buses with well-operating catalysts offer net emissions benefits when substituted for old and recent-model diesel buses. This paper makes no attempt to weigh emissions or to estimate air quality and does not estimate net emissions benefits. It is shown that pollutant-specific emissions from the test methanol vehicles are highly variable with average speed and are dependent on the engine technology and the emission-control devices used. It is also shown that the change in emissions resulting from the substitution of a methanol bus for a diesel bus can often be positive or negative for a single pollutant, depending on how the buses are driven. DOE

N90-18045# Society of Automotive Engineers of Japan, Tokyo.
PRELIMINARY COLLECTION 891 OF LECTURES/PAPERS IN SYMPOSIUM BY SOCIETY OF AUTOMOTIVE ENGINEERS OF JAPAN
29 May 1989 366 p In JAPANESE Proceedings of the Society of Automotive Engineers of Japan Meeting, Tokyo, Japan, 29 May 1989
(DE90-710449; SAEJ-8901; CONF-8905238) Avail: NTIS (US Sales Only) HC A16/MF A02

This preliminary collection is composed of lectures given and papers presented in the symposium. Totally 86 papers, together with two basic lectures, were presented therein. The categories include: two basic lectures titled, Future Problems on CVT and Automatic Transmission, and Advances of Gasoline Engine and Measuring Techniques; ten papers for the gasoline engine, covering the supercharger, air/fuel mixture, noise, and bore deformation; ten papers for the diesel engine, covering the exhaust gas, supercharger, and methanol engine; ten papers for the car body, covering the aerodynamical characteristics and movement of car body, movement analysis of motor bicycle, head lamp, and painting; ten papers for the car parts; ten papers for the fuel injection; ten papers for the engine parts, covering the piston, oil ring, cylinder, connecting rod, plug, rotary, and car heater; three papers for the car production, covering the line control, welding, and production method; seven papers for the car steering and stability; eight papers for the vibration and noise attenuation; and three papers for the others. DOE

N90-18046# New Energy Development Organization, Tokyo (Japan).
SURVEYS CONCERNING THE EFFECT TO INTRODUCE ELECTRIC VEHICLES. ON THE POSSIBILITY OF NEW TECHNOLOGY AND INTRODUCING MEASURES
Mar. 1989 117 p In JAPANESE; ENGLISH summary
(DE90-742057; NEDOJ-P-8823) Avail: NTIS (US Sales Only) HC A06/MF A01

The surveys are presented concerning the effects of the introduction of electric vehicles and development problems. Technological development and efforts to popularization have been promoted to prevent air pollution, to reduce the dependence on oil and to improve power load factor. But more improvements must be made and on the technology and on the soft technique in order to popularize the technology. The increase of running distance due to superconducting magnetic energy storage utilizing regenerative brake and lightening and the running distance elongation due to the inductive power from the buried inductive coupling system are studied to overcome the limit of secondary battery. Solar cars utilizing solar energy are paid attention but they inferior to the battery system. Problems to widen electric cars are inferior, requiring the arrangement of supporting system such as charging, maintenance, relevant legislations, and necessitating personal and social consensus. It is necessary to clarify the concept and positioning, to carry out positively and to continue the appeal and technical development on the basis of long term visions to popularize the electric vehicles. DOE

N90-18047 Northwestern Univ., Evanston, IL.
SCUFFING MODELLING AND EXPERIMENTS FOR HEAVILY LOADED ELASTOHYDRODYNAMIC LUBRICATION CONTACTS Ph.D. Thesis
Si Choon Lee 1989 146 p
Avail: Univ. Microfilms Order No. DA9001829

The lubrication breakdown leading to rapid adhesive wear in rolling and sliding contacts is known as scuffing. This breakdown

occurs when the asperity oil film, surface film, and oxide film on the asperities cease to be effective. Scuffing experiments were conducted on a twin disk machine using straight mineral oil. The experimental results were correlated with a new scuffing model based on adsorption and desorption theory. They were also correlated with the existing theories based on the breakdown of the hydrodynamic lubrication film and protective surface film. In order to test out the validity of the scuffing models, the partial ehl (elastohydrodynamic lubrication) for line contacts was solved using a newly developed concept, average gap. The effect of surface roughness on lubrication was taken into account by digitizing the actual profiles of the mating surfaces and mathematically simulating the contacts between them. A method of calculating the asperity flash temperature distributions in partial ehl contacts is formulated - the necessary inputs for the flash temperature calculations are taken from the results of rough surface contact simulations and partial ehl calculations. Both the flash temperatures and partial ehl solutions are necessary in testing out the validity of the scuffing theories. Dissert. Abstr.

N90-18048# Naval Postgraduate School, Monterey, CA.
AN AUTONOMOUS PLATFORM SIMULATOR (APS) M.S. Thesis
Larry R. Shannon and William A. Teter Jun. 1989 202 p
(AD-A215768) Avail: NTIS HC A10/MF A01 CSCL 12/9

The development of an intelligent autonomous vehicle, that can perform high risk missions or operate in environments too hazardous for humans, has been a long standing quest of the military community. The Autonomous Platform Simulator (APS) uses the flexibility and power of realistic graphical simulation to provide a low cost testbed for the study of real-time path planning algorithms and control strategies without the commitment of resources involved in building a prototype system. It is a bridge between the theoretical study of an abstract AI path planning problem and applied research, producing concrete performance measurements under realistic conditions. APS consists of one or more vehicle simulators, each implemented on a Silicon Graphics IRIS/4D-70GT graphics workstation. One vehicle simulator is linked with an AI agent path planner, implemented on a pair of Symbolics AI workstations using the Automated Reasoning Tool development shell. System trails demonstrated that APS was able to achieve real-time path planning and guidance of a realistically depicted ground vehicle navigating using digitized data of actual terrain. Communication bottlenecks currently limit the ability to make direct comparisons between human and machine control, but the system holds promise to fill the gap as a pre-prototype autonomous platforms simulator. GRA

N90-18049# Carnegie-Mellon Univ., Pittsburgh, PA. Robotics Inst.
DEVELOPMENT OF AN INTEGRATED MOBILE ROBOT SYSTEM AT CARNEGIE MELLON UNIVERSITY: JUNE 1988 Annual Report, Jul. 1987 - Jun. 1988
Steve Shafer and William Whittaker Jul. 1989 62 p
(Contract DACA76-86-C-0019; DARPA Order 5682)
(AD-A215955; CMU-RI-TR-89-22) Avail: NTIS HC A04/MF A01 CSCL 12/9

This program focused on the NAVLAB computer-controlled van. During this report period, we addressed major issues in both hardware and software for integrated autonomous mobile robots: (1) the NAVLAB mobile robot vehicle was built by outfitting a commercial truck chassis with computer-controlled drive and steering controls and a set of on-board computer workstations. The NAVLAB serves as a mobile navigation laboratory that allows researchers to interact intensively with the system during testing and execution. This year has seen a continued evolution and improvement of the NAVLAB mechanism, sensors, controller, and Virtual Vehicle interface to higher-level planning and perception software, (2) previously we designed and implemented the CODGER blackboard system for robot perception and reasoning on a distributed collection of processors. This year we have upgraded it to deal with geometric models and uncertainty in perception and map data, and (3) to control the NAVLAB and Terregator mobile robot vehicles, we developed the Driving Pipeline architecture last year for coordinating road following, obstacle avoidance, and vehicle motion control. In our ongoing research, we performed numerous experiments with this system that demonstrate its value. This hardware and software is the basis for the New Generation System (NGS) for robot vision and navigation, which integrates many independent technologies. GRA

N90-18050# Carnegie-Mellon Univ., Pittsburgh, PA. Robotics Inst.
RAPID PROTOTYPING OF TOOLS
Lee E. Weiss, E. Levent Gursoz, F. B. Prinz, Swami Mahalingham, and Paul S. Fussell Oct. 1989 28 p Sponsored in part by NSF, and by Alcoa Labs.
(Contract N00014-88-K-0642)
(AD-A215956; CMU-RI-TR-89-25) Avail: NTIS HC A03/MF A01 CSCL 13/9

This report describes a system for rapid tool manufacturing based on the integration of stereolithograph and thermal spraying. With stereolithography apparatus (SLA), plastic prototype models are built directly from a vat of liquid photocurable polymer by selectively solidifying it with a scanning laser beam. Thermal spraying is then used to incrementally deposit metal onto the SLA models. A freestanding metal structure is formed by separating the metal shell from the plastic substrate. By mounting the shell in a frame and backing it up with appropriate materials, a broad range of tooling can be fabricated including injection molds, forming dies, and EDM electrodes. The system integrates SLA and thermal spraying into a CAD/CAM environment which includes design evaluation tools, robotic spray capability, and computer-aided process planning. Information flows efficiently from design through fabrication by incorporating a common geometric modeling system for part and process representations. Our goal is to demonstrate that automating and integrating these processes, within a unified modeling environment, can significantly improve productivity through greater design flexibility, rapid fabrication, and cost-reduction. We have established the system framework and developed several of the system components. This report describes a case-study for the application of this technology to injection mold manufacture. GRA

N90-18051# Carnegie-Mellon Univ., Pittsburgh, PA. Robotics Inst.
CHIMERA 2: A REAL-TIME UNIX-COMPATIBLE MULTIPROCESSOR OPERATING SYSTEM FOR SENSOR-BASED CONTROL APPLICATIONS
David B. Stewart, Donald E. Schmitz, and Pradeep K. Khosla Sep. 1989 37 p
(AD-A215958; CMU-RI-TR-89-24) Avail: NTIS HC A03/MF A01 CSCL 12/5

This paper describes the CHIMERA 2 multiprocessing operating system, which has been developed to provide the flexibility, performance, and UNIX-compatible interface needed for fast development and implementation of parallel real-time control code. The operating system is intended for sensor-based control applications such as robotics, process control, and manufacturing. The features of CHIMERA 2 include support for multiple general purpose CPUs; support for multiple special purpose processors and I/O devices; a high performance real-time multitasking kernel; user redefinable dynamic real-time schedulers; a UNIX-like environment, which supports most standard C system and library calls; standardized interrupt and exception handlers; and a user interface which serves to download, monitor, and debug code on any processor board, and serves as a terminal interface to the executing code. CHIMERA 2 also offers an attractive set of interprocessor communication features. The system-level express mail facility provides transparent access to a host file system and remote devices, and provides the basis for implementing user-level interprocessor communication. Application programmers have the choice of using shared memory, message passing, remote semaphores, or other special synchronization primitives for communicating between multiple processors. GRA

N90-18052# Carnegie-Mellon Univ., Pittsburgh, PA. Robotics Inst.

SHAPE FROM FOCUS

Shree K. Nayar Nov. 1989 37 p Sponsored by Hitachi Ltd., Yokohama, Japan

(AD-A215959; CMU-RI-TR-89-27) Avail: NTIS HC A03/MF A01 CSCL 12/9

Rough surfaces pose a challenging shape extraction problem. Images of rough surfaces are often characterized by high frequency intensity variations, and it is difficult to perceive the shapes of these surfaces from their images. The shape-from-focus method described here uses different focus levels to obtain a sequence of object images. The sum-modified-Laplacian (SML) operator is developed to compute local measures of the quality of image focus. The SML operator is applied to the image sequence, and the set of focus measures obtained at each image point is used to compute local depth estimates. We present two algorithms for depth estimation. The first algorithm simply looks for the focus level that maximizes the focus measure at each point. The other algorithm models the SML focus measure variations at each point as a Gaussian distribution and use this model to interpolate the computed focus measures to obtain more accurate depth estimates. The algorithms were implemented and tested using surfaces of different roughness and reflectance properties. We conclude with a brief discussion on how the proposed method can be applied to smooth textured and smooth non-textured surfaces. GRA

N90-18053# Pulse Sciences, Inc., San Leandro, CA.

AURORA UPGRADE. VOLUME 5: MACHINE MONITORING AND CONTROL SYSTEM

L. Schlitt, W. Weseloh, D. Morton, D. Garofolo, and A. Ball 1 Dec. 1989 77 p

(Contract DNA001-85-C-0140)

(AD-A215963; PSI-FR-219-05; DNA-TR-88-98-V5) Avail: NTIS HC A05/MF A01 CSCL 14/2

The objectives for the Aurora Machine Monitoring and control (MMC) task of DNA Contract DNA 001-85-C-0140 were to design, develop, fabricate, and install a monitor and control system that would significantly increase the amount and quality of the operational information obtained from the Aurora simulator, and to assist the Aurora staff in the operation of the simulator. The accomplishment of these objectives required the design and acquisition of a wide range of hardware and the development of a substantive software package. At the time the MMC was started, the Aurora simulator was in need of upgrading and refurbishment of a number of its sensor systems. In particular, many of the gas pressure sensors and gauges were either inoperative or inaccurate. The Aurora staff also desired replacement of the high vacuum gauges as well as additional gauges. These requirements were to be addressed in the MMC task. GRA

N90-18054# Southwest Research Inst., San Antonio, TX. Fuels and Lubricants Research Facility.

US ARMY METHANOL-FUELED ADMINISTRATIVE VEHICLE DEMONSTRATION PROGRAM Final Report, Mar. 1986 - Aug. 1989

Burl B. Baber, Sidney J. Lestz, and Maurice E. LePera (Army Belvoir Research and Development Center, Fort Belvoir, VA.) Aug. 1989 254 p

(Contracts DAAK70-85-C-0007; DAAK70-87-C-0043; DA Proj. 1L2-63001-D-150)

(AD-A216013; BFLRF-233) Avail: NTIS HC A12/MF A02 CSCL 21/4

A methanol-fueled fleet test demonstration program was conducted using administrative-type vehicles to determine the feasibility of using methanol as an alternative fuel. Over 1,026,000 miles were accumulated using 64 administrative-type vehicles. Approximately 750,000 of these miles were accumulated using M85 methanol fuel. Existing engines engineered for use with gasoline and special methanol engines engineered for use with M85 methanol fuel were included in the program. Fuel economy, in miles per gallon, obtained for vehicles using M85 fuel is shown to be approximately one-half that obtained using regular unleaded gasoline. When the costs of M85 fuel and unleaded gasoline are included in economic calculations, it is shown that using M85 increases the fuel cost by a factor of approximately 3.0. No catastrophic engine failure occurred using either fuel. Even though wear rates, indicated from used oil sample analyses, obtained when using M85 fuel appear to be 2 to 4 times those obtained using unleaded gasoline, actual wear, from inspections and measurements, does not appear to be as severe. No significant increase in individual vehicle maintenance, other than increased oil drains, was noted for the methanol vehicles. The M85 refueling stations were set up at four fleet test sites, and no significant operational problem, safety or otherwise, was encountered during the program. GRA

N90-18055# Southwest Research Inst., San Antonio, TX. Fuels and Lubricants Research Facility.

VEHICLE ACCELERATION AND FUEL CONSUMPTION WHEN OPERATED ON JP-8 FUEL Interim Report, 1 Jun. 1988 - 28 Feb. 1989

Edwin C. Owens, Douglas M. Yost, and Sidney J. Lestz Feb. 1989 47 p

(Contract DAAK70-87-C-0043; DA Proj. 1L2-63001-D-150)

(AD-A216275; BFLRF-257) Avail: NTIS HC A03/MF A01 CSCL 21/4

A limited test program (eight combat and tactical vehicles) was conducted to obtain a quantitative estimate of the change in combat and tactical vehicle performance and fuel consumption that would occur when converting the military fleet to MIL-T-83133 JP-8 (F-34) fuel. Data specifically desired included startability and idle quality, acceleration rates, and fuel consumption. Also, a comparative assessment of the on-vehicle smoke production capabilities of combat vehicles with the two fuels was desired. As a result of these tests, it was determined that substitution of JP-8 for DF-2 reduced the acceleration rates, and thus power, of all vehicles tested except for the M928 and M1009 vehicles, which improved or remained the same. Also, all vehicles tested, except for the M88A1 light recovery vehicles, had fuel consumption increases with JP-8 that were at or below that predicted by the heating value difference between the two fuels. No drivability or idle problems occurred with any of the test vehicles. GRA

N90-18056# Army Engineer Waterways Experiment Station, Vicksburg, MS. Geotechnical Lab.

LUNAR SURFACE MOBILITY STUDIES, PAST AND FUTURE Final Report

Gerald W. Turnage and Don C. Banks Nov. 1989 44 p Sponsored by Corps of Engineers, Washington, DC

(AD-A216451; WES/MP/GL-89-26) Avail: NTIS HC A03/MF A01 CSCL 22/1

WES efforts contributed to selection of the metal-elastic wheels successfully used on the Lunar Roving Vehicle (LRV) and produced a quantitative description of the high level mobility capabilities of a concept tracked running gear proposed for future U.S. lunar surface applications (the Elastic Loop Mobility System, or ELMS). Highlights of those Apollo-era studies are reviewed: the determination and quantitative characterization of two terrestrial soils each successfully processed to provide a lunar soil simulant (LSS); and the analysis of results from mobility tests conducted in LSS with several candidate LRV wheels and with several versions of the ELMS. Capabilities developed since Apollo for use today in analyzing the mobility and soil working potential of future U.S. LRV's are described. These capabilities include judicious application of soil running gear dimensional analysis relations, plus the use of computerized models to be modified from terrestrial to lunar applications for predicting vehicle mobility and bulldozer working capability (e.g., the Army Mobility Model and the Push-It Model, respectively). Future studies of lunar surface vehicle mobility capabilities must profit from two major lessons learned from Apollo, i.e., how to process and quantitatively describe LSS, and to appreciate that physical testing in LSS of proposed running gears and vehicles is a necessary part of lunar vehicle mobility studies. GRA

38 QUALITY ASSURANCE AND RELIABILITY

Includes product sampling procedures and techniques; and quality control.

N90-18057*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
SOFTWARE VERIFICATION PLAN FOR GCS
Leslie A. Dent, Anita M. Shagnea (Research Triangle Inst., Research Triangle Park, NC.), and Kelly J. Hayhurst Jan. 1990 112 p
(NASA-TM-101668; NAS 1.15:101668) Avail: NTIS HC A06/MF A01 CSCL 09B

This verification plan is written as part of an experiment designed to study the fundamental characteristics of the software failure process. The experiment will be conducted using several implementations of software that were produced according to industry-standard guidelines, namely the Radio Technical Commission for Aeronautics RTCA/DO-178A guidelines, Software Consideration in Airborne Systems and Equipment Certification, for the development of flight software. This plan fulfills the DO-178A requirements for providing instructions on the testing of each implementation of software. The plan details the verification activities to be performed at each phase in the development process, contains a step by step description of the testing procedures, and discusses all of the tools used throughout the verification process. Author

N90-18058# Rome Air Development Center, Griffiss AFB, NY.
RADC RELIABILITY ENGINEER'S TOOLKIT
Seymour F. Morris, Preston R. MacDiarmid, Anthony J. Feduccia, Bruce W. Dudley, Jerome Klion, and David Garafalo Oct. 1989 243 p
(AD-A215977; RADC-TR-89-171) Avail: NTIS HC A11/MF A01 CSCL 20/3

The Reliability Engineer's TOOLKIT is an application oriented guide aimed primarily at the practicing reliability engineer but is also highly useful in providing others with a better understanding of R and M principles and techniques. It summarizes time tested reliability and maintainability (R and M) concepts and techniques for developing reliable electronic hardware. It applies primarily to advanced development and full scale engineering development projects. The TOOLKIT specifically covers numerous topics which will result in the attainment of more reliable and maintainable hardware. It addresses the practical application of proven R and M techniques which, when properly applied, will assist all hardware in meeting the R and M 2000 goals. The TOOLKIT summarizes, in the form of checklists, tables, and step-by-step procedures information needed during: R and M requirements development; contractor proposal evaluation for R&M; participation in the R and M design process. GRA

N90-18059# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Systems and Logistics.
APPLICATION OF BAYESIAN RELIABILITY CONCEPTS TO CRUISE MISSILE ELECTRONIC COMPONENTS M.S. Thesis
Richard K. Lemaster Sep. 1989 124 p
(AD-A216208; AFIT/GSM/LSG/89S-24) Avail: NTIS HC A06/MF A01 CSCL 16/4

The purpose of this thesis was to evaluate the applicability of Bayesian statistical methods to the problem of determining cruise missile component reliability. There were three objectives: (1) to develop models incorporating Bayesian reliability concepts that can be used to predict component reliability based on data available in a program transitioning from development to production; (2) tp determine the model's validity in comparison with classical statistical models; and (3) to assess the accuracy of both approaches against actual cruise missile flight test history. A total of six models were developed for the failure rate of the Tomahawk Cruise Missile Guidance Set using both exponential and binomial distributions. The flight test data seemed to belong to another failure distribution, and was not useful as a measure of performance as had been proposed. The Bayesian Expert Information Model provided reasonable point estimates of the failure rate and markedly shorter 90 percent confidence intervals. In general, the Bayesian models had confidence intervals that were shorter than the classical statistical inference models, allowing a more accurate decision-making process. GRA

39 STRUCTURAL MECHANICS

Includes structural element design and weight analysis; fatigue; and thermal stress.

For applications see *05 Aircraft Design, Testing and Performance* and *18 Spacecraft Design, Testing and Performance.*

N90-18060 Washington Univ., Seattle.
ANALYSIS OF DUCTILE FRACTURE UNDER BIAXIAL LOADING USING MOIRE INTERFEROMETRY Ph.D. Thesis
Mahyar Sh Dadkhah 1988 199 p
Avail: Univ. Microfilms Order No. DA8911619

An improved moire interferometry setup, which records both the vertical and horizontal displacements simultaneously, was constructed to study ductile crack initiation and stable crack growth in aluminum alloys under the influence of biaxial loading. Whole-field measurements were used to evaluate the crack opening displacement (COD), far and near-field J-integral values and the Hutchinson-Rice-Rosengren, HRR, fields. The behavior of crack growth under the influence of biaxial stress was evaluated by conducting crack propagation tests on cruciform specimens made of 2024-0, 2024-T3 and 5052-H32 aluminum alloys. Tests were conducted at various biaxial load ratios. Contour maps of u- and v-displacement fields were obtained by moire interferometry, using reference virtual gratings of 1200 lines/mm (30480 l/in). A computer based data reduction scheme, which automatically reduces the whole-field displacement fields measured using moire interferometry to strain, stress and subsequently J-Integral within the confine of a constitutive relation for selected contours, was developed. The J-values associated with stable crack growth in biaxially loaded 2024-T3, 2024-0 and 5052-H32 aluminum, single edge notched cruciform specimens, were found to be path independent and increased with crack extension. The transient displacement fields at the onset of crack initiation and during crack extensions up to 5.6 mm were used to evaluate the J-resistence, J(sub r), curves. J(sub r) curves were identical within the scatter of data for all three different biaxial load ratios. Dissert. Abstr.

N90-18061# Pennsylvania State Univ., University Park. Applied Research Lab.
ADAPTIVE VIBRATION CONTROL OF VIBRATION ISOLATION MOUNTS, USING AN LMS-BASED CONTROL ALGORITHM
Scott Sommerfeldt and Jiri Tichy Nov. 1989 151 p Sponsored by Dept. of the Navy
(AD-A214386; ARL/PSU/TR-89-007) Avail: NTIS HC A08/MF A01 CSCL 20/11

The possibility is investigated of actively controlling a two-stage vibration isolation mount so as to minimize the transmissibility through the mount. Based on the least mean squares (LMS) algorithm, an adaptive control system is developed which performs both system identification and control in real time. The algorithm is generalized to be applicable for systems with multiple actuators and/or sensors. To demonstrate its performance, the adaptive controller is applied to a two-stage isolation mount to actively control vibration transmission through the mount. Experimental results are presented for both narrowband and broadband excitation signals. To demonstrate the capability of the controller to track changing systems, results are shown for several cases where the parameters of the two-stage isolation mount change in time. It is shown that adaptive control presents an excellent means of achieving optimal control at low frequencies where conventional passive control methods fail. The issue of stability is investigated for several LMS-based algorithms, and it is demonstrated that narrower stability restrictions occur as a result of the transfer

function between the control filter and the error sensor which exists in a physical system. The result is that in order to maintain stability, the algorithms have a smaller maximum convergence parameter for noise or vibration control applications than for corresponding signal processing applications with the same input. GRA

N90-18062 Virginia Polytechnic Inst. and State Univ., Blacksburg.
A STUDY OF NEAR TIP PHENOMENA FOR CRACKS IN A PARTICULATE COMPOSITE Ph.D. Thesis
Mohamad A. Rezvani 1989 109 p
Avail: Univ. Microfilms Order No. DA8922363

An experimental investigation using grids with a frequency of 125 lines/in. (5 lines/mm) was performed on inert propellant and pure binder at two different global head rates of 0.1 in./min (2.5 mm/min) and 1.0 in./min (25.4 mm/min). From the extracted data, displacements, strains, and dominant eigenvalue for displacement were calculated. An idealized model was used to explain the high strain zone ahead of inert propellant that caused severe blunting at the crack tip. Using the available algorithms and 3-D photoelasticity, the dominant stress singularity order values were calculated in a four point single edged crack bend specimen with both straight front and thumbnailed cracks. The free surface values are the same as for the inert propellant and in good agreement with analytical values. A boundary layer is observed in the singularity order which extends towards the mid-plane of the specimen. This region is about 20 percent of the distance from the free surface to mid-depth of the fractured body. The slow and fast head rates alter the global behavior of the specimen as well as the density of the displacement and strain contours. However, the near tip mechanisms are not altered. Dissert. Abstr.

N90-18063*# Institute for Computer Applications in Science and Engineering, Hampton, VA.
ROBUSTNESS OF CONTROLLERS DESIGNED USING GALERKIN TYPE APPROXIMATIONS Final Report
K. A. Morris (Waterloo Univ., Ontario) Jan. 1990 21 p Submitted for publication
(Contract NAS1-18605)
(NASA-CR-181986; NAS 1.26:181986; ICASE-90-12) Avail: NTIS HC A03/MF A01 CSCL 20K

One of the difficulties in designing controllers for infinite-dimensional systems arises from attempting to calculate a state for the system. It is shown that Galerkin type approximations can be used to design controllers which will perform as designed when implemented on the original infinite-dimensional system. No assumptions, other than those typically employed in numerical analysis, are made on the approximating scheme. Author

N90-18064*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
STEADY-STATE AND TRANSIENT ZENER PARAMETERS IN VISCOPLASTICITY: DRAG STRENGTH VERSUS YIELD STRENGTH
A. D. Freed and K. P. Walker (Engineering Science Software, Inc., Smithfield, RI.) 1990 12 p Proposed for presentation at the 11th US National Congress of Applied Mechanics, Tucson, AZ, 21-25 May 1990
(NASA-TM-102487; E-5278; NAS 1.15:102487) Avail: NTIS HC A03/MF A01 CSCL 20K

A hypothesis is put forth which enables the viscoplastician to formulate a theory of viscoplasticity that reduces, in closed form, to the classical theory of creep. This hypothesis is applied to a variety of drag and yield strength models. Because of two theoretical restrictions that are a consequence of this hypothesis, three different yield strength models and one drag strength model are shown to be theoretically admissible. One of these yield strength models is selected as being the most appropriate representation for isotropic hardening. Author

N90-18065# Sandia National Labs., Albuquerque, NM.
THE 59TH SHOCK AND VIBRATION SYMPOSIUM, VOLUME 2
Henry C. Pusey, comp. and Sallie C. Pusey, comp. Oct. 1988 408 p Symposium held in Albuquerque, NM, 18-20 Oct. 1988; sponsored by DOD
(Contract DE-AC04-76DP-00789)
(AD-A214579; SAND-88-2473C-Vol-2; UC-13-Vol-2) Avail: NTIS HC A18/MF A03 CSCL 20/11

Some titles of articles presented in the volume are presented: Dynamic testing (STAR 63F Q-3 qualification vibration test); Correlation between vibration and computer operator response onboard a UH-1H helicopter; Shaker shock testing using nonstationary random transients; and High velocity impact testing of an accident resistant container using a large centrifuge; Shock (Pyrotechnic shock data reduction procedures and problems); Time domain analysis of pyrotechnic shock using resonant beam test apparatus; Equipment limitations in pyrotechnic shock testing; Shock response spectrum anomalies which occur due to imperfections in the data; Fourier transform for almost any number of data points with reasonable run times; Shock spectrum for classes of excitations; Technical procedure for optimum shock hardening of aircraft support equipment; and Boundary integral technique for explosion bubble collapse analysis; Dynamic analysis (Modeling vibration transmission in a damped beam structure using statistical energy analysis); Solar array deployment nonlinear dynamics analysis; Experimental observations of low and zero gravity nonlinear fluid-spacecraft dynamics; Vibratory system dynamic analysis using a graphics based self-formulating program; and Design of upper atmosphere research satellite using transient loads analysis. Author

N90-18066# Sandia National Labs., Albuquerque, NM.
THE 59TH SHOCK AND VIBRATION SYMPOSIUM, VOLUME 3
Henry C. Pusey, comp. and Sallie C. Pusey, comp. Oct. 1988 332 p Symposium held in Albuquerque, NM, 18-20 Oct. 1988; sponsored by DOD
(Contract DE-AC04-76DP-00789)
(AD-A214580; SAND-88-2473C-Vol-3; UC-13-Vol-3) Avail: NTIS HC A15/MF A02 CSCL 20/11

Some of the content areas of this volume are presented. They are: Machinery vibration (Mechanical signature analysis); High frequency vibration analysis for rotating equipment and piping systems; Diagnosing problems in modern 2-pole induction motors; Absolute ball bearing wear measurements from SSME turbopump dynamic signals; Spectral normalizing, and Kinematics of a flexible length redundant robotic arm; Vibration control (Optimization of a five-parameter nonlinear shock mount); Active damping design of flexible structures based on non collocated sensor-actuator velocity feedback; Relating material properties and wave effects in vibration isolators; Compensation for actuator dynamic effects using model following adaptive control; Damping and vibration control of unidirectional composite beams using add-on viscoelastic materials; Creep and load-deflection characteristics of rubber element for vibration control devices; Airblast (Envelope models for finding the response of structures in blast waves); Dynamic nonlinear frame analysis for blast and shock; Behavior of a reinforced concrete blast shelter in an overload environment; Shelter response in a simulated 8-KT nuclear blast environment; and Blast induced liquefaction field explosive tests; Wave coupling and resonance in gun tubes; Blast field produced by a cannon having a perforated muzzle brake; Lagrangian modelling of blunt projectile impacts against thick plates; and Analytical estimate of artillery projectile balloting load. Author

N90-18067# Dayton Univ., OH. Electronic and Computer Development Lab.
Z-GRID SIGNAL CONDITIONING SYSTEM USER'S GUIDE AND TECHNICAL REFERENCE Final Report, Sep. 1985 - Sep. 1988
Michael Joseph Gutman, Robert Edson Blanchard, and James Michael Aulds May 1989 135 p
(Contract F33615-85-C-2585; AF Proj. 3066)
(AD-A215122; UDR-TR-88-134; WRDC-TR-89-2043) Avail: NTIS HC A07/MF A01 CSCL 21/5

This report provides design and technical documentation on the electronic processing of vibration signals from the Z-Grid

method of noncontacting blade tip deflection sensing. The Z-Grid system is used as an analytical tool for structural testing and research on bladed disk components. The signal conditioning system is designed to process two frequency modulated waveforms generated by the relative motion of a permanent magnet with respect to a conducting wire grid. GRA

N90-18068# Construcciones Aeronauticas S.A., Madrid (Spain). Subdireccion de Investigacion y Desarrollo de Tecnologia y Materiales.
BEARING TESTS IN Ti-6Al-4V PLATES MADE USING SUPERPLASTIC FORMING [ENSAYOS DE APLASTAMIENTO DE TALADROS (BEARING TEST) EN CHAPAS DE Ti-6AL-4V CONFORMADAS SUPERPLASTICAMENTE]
L. E. Lopez and C. Serrano 5 May 1989 9 p In SPANISH
(INFORME-I-357/89; ETN-90-96185) Avail: NTIS HC A02/MF A01

Double shear tests using 4.85 diameter rivets joining flat plates of Ti-6Al-4V alloy were carried out. The specimens were cut from superplastic formed plates used in aircraft construction. The results found are 2453 mpa for the bearing strength and 1277 to 1757 mpa for elastic yield. ESA

N90-18069*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
DYNAMICS OF COLUMN STABILITY WITH PARTIAL END RESTRAINTS
Peyton B. Gregory Jan. 1990 109 p
(NASA-TM-101651; NAS 1.15:101651) Avail: NTIS HC A06/MF A01 CSCL 20K

The dynamic behavior of columns with partial end restraints and loads consisting of a dead load and a pulsating load are investigated. The differential equation is solved using a lumped impulse recurrence formula relative to time coupled with a finite difference discretization along the member length. A computer program is written from which the first critical frequencies are found as a function of end stiffness. The case of a pinned ended column compares very well with the exact solution. Also, the natural frequency and buckling load formulas are derived for equal and unequal end restraints. Author

N90-18070*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
A STUDY OF THE STRUCTURAL EFFICIENCY OF FLUTED CORE GRAPHITE-EPOXY PANELS
Dawn C. Jegley Jan. 1990 18 p
(NASA-TM-101681; NAS 1.15:101681) Avail: NTIS HC A03/MF A01 CSCL 20K

The structural efficiency of compression-loaded graphite-epoxy sandwich panels with fluted cores is studied to determine their weight saving potential. Graphite-epoxy equilateral triangular elements are used to construct the fluted cores for the sandwich panels. Two panel configurations are considered. One configuration has two layers of triangular elements in the fluted core and the second configuration has only one layer of triangular elements in the core. An optimization code is used to find the minimum weight design for each panel configuration. Laminate ply orientations are limited to approx. 45, 0, and 90 deg. A constraint on the axial stiffness is included in the design process so the panel will conform to typical constraints for aircraft wing structures. Minimum thickness requirements for each laminate and maximum allowable strains are also included. A comparison is made of the calculated structural efficiency of the fluted core panels to the structural efficiency of aluminum transport aircraft structures and simple blade-stiffened graphite-epoxy panels. Limited experimental results are also included for comparison with the analytical predictions and to identify the critical failure mechanisms of graphite-epoxy fluted-core sandwich panels. Author

N90-18071*# Pittsburgh Univ., PA. Dept. of Mechanical Engineering.
TRANSIENT FINITE ELEMENT COMPUTATIONS ON THE TRANSPUTER SYSTEM Final Report
Patrick J. Smolinski Feb. 1990 37 p
(Grant NAG3-829)
(NASA-CR-185199; NAS 1.26:185199) Avail: NTIS HC A03/MF A01 CSCL 20K

The aim was to study the solution of transient finite element problems on the Transputer system of parallel processors. The central difference time integration rule was used so that no equation solving was necessary. Also investigated was subcycling time integration which uses different time steps in different subdomains of the finite element mesh. A one-dimensional bar problem was analyzed using the parallel time integration algorithm. This involves subdividing the bar into subproblems which are assigned to different processors. Results show that the significant speed-up can be obtained through parallel processing. Also subcycling can give an additional speed-up in certain classes of problems. A two-dimensional problem was also examined to evaluate the effect of the communication to computation ratio on solution time. Author

N90-18072# Sandia National Labs., Albuquerque, NM.
COHERENT PHASE TRANSFORMATION UNDER NONHYDROSTATIC STRESS-WAVE LOADING
D. E. Grady Dec. 1989 39 p
(Contract DE-AC04-76DP-00789)
(DE90-005719; SAND-89-2339) Avail: NTIS HC A03/MF A01

Coherent phase transformation occurs under conditions of stress wave loading and there are indications that transformation is dependent on the nonhydrostatic state of stress in the body. Studies under static loading show transformation proceeds at lower confining pressure when combined with shearing stress and similar effects appear to occur under stress-wave loading. Nonlinearities in the stress-strain behavior due to the transformation strain lead to complicated wave propagation, including wave separation and rarefaction shock waves. In the present study a thermodynamic theory of the combined elastic and phase transformtion deformation is developed which incorporates the interrelation of pressure and shear effects. The theory is focused on wave propagation in solids and is compared with earlier experimental work on Oakhall limestone. A thermodynamic Gibbs potential is derived for the material and a phase equilibrium relation identified, which constrains the volume and shape change through the transformation. The theory is extended to account for the effect of microstructural heterogeneities on the transformation process which has been observed experimentally. DOE

N90-18073# Lawrence Livermore National Lab., CA.
NUMERICAL MODEL OF BOND STRENGTH MEASUREMENTS
Gerald L. Nutt Dec. 1989 6 p Presented at the Materials Research Society Fall Meeting, Boston, MA, 27 Nov. - 2 Dec. 1989 Submitted for publication
(Contract W-7405-eng-48)
(DE90-006000; UCRL-102521; CONF-891119-74) Avail: NTIS HC A02/MF A01

Bond strength measurements are reported of metal/ceramic interfaces using shock waves to separate the bond by spallation. The technique relies on the interpretation of the free surface velocity of the metal film as it is spalled from the substrate. Several questions are answered relating to the details of the interaction of the shock with the interface. Specifically, the role of sound speeds in the measurements is examined. The plastic strain in the bond region is also examined and the theory relating to the jumpoff velocity of the scab to the bond strength is verified. DOE

N90-18074 Cincinnati Univ., OH.
TRANSIENT ELASTIC WAVES ON ANISOTROPIC HALF-SPACES Ph.D. Thesis
Timothy William Taylor 1989 115 p
Avail: Univ. Microfilms Order No. DA9003262

The response of an anisotropic semi-infinite half-space subjected to a line load is presented. The material considered in this treatment may have anisotropy up to the order of monoclinic. The three dimensional partial differential equations of motion are

transformed into coupled ordinary differential equations with the aid of the Laplace and Fourier transformations. The formal solution of the resulting ordinary coupled differential equations is then easily determined using superposition. Taking the inverse Fourier transform of the formal solution leaves the solution in the form of a singular integral equation. Using the technique introduced by Cagniard and deHoop, a transformation is introduced that parameterizes the solution in terms of time and results in an expression that is easily recognized as a Laplace transform. The expressions for the displacements and stresses can then be obtained merely by inspection. Results are presented in the form of displacement or stress versus time at selected spatial locations. Several materials are investigated including isotropic, perturbed isotropic, and orthotropic materials. The effect of anisotropy is investigated by the use of the slightly perturbed isotropic material and an orthotropic material. Dissert. Abstr.

N90-18075# Army Materials Technology Lab., Watertown, MA. Mechanics and Structures Branch.

A HIGHER-ORDER PLATE THEORY WITH IDEAL FINITE ELEMENT SUITABILITY Final Report

Alexander Tessler Sep. 1989 27 p Sponsored by Army Lab. Command, Adelphi, MD

(AD-A216163; MTL-TR-89-85) Avail: NTIS HC A03/MF A01 CSCL 20/11

A variationally consistent tenth-order displacement theory of stretching and bending of orthotropic elastic plates is proposed which leads itself perfectly to finite element formulations based upon C and C-continuous displacement approximations. The deformations due to all strain and stress components are accounted. The theory is derived from three-dimensional elasticity via the principle of virtual work by expanding the displacement components with respect to the thickness coordinate by means of Legendre polynomials, where the transverse displacement is of a special parabolic form while the inplane displacements are linear. The issues of thickness-expansion related inconsistencies in the transverse shear strains and the transverse normal stress are resolved in a rational fashion. The resulting parabolic shear strains incorporate Reissner's shear correction factor, while the transverse normal strain varies cubically across the plate thickness. The variational principle yields seven equations of motion and exclusively Poisson-type edge boundary conditions. A qualitative assessment of the theory is carried out for the problem of static equilibrium involving an infinite plate under a sinusoidal normal pressure. Pertinent issues on the particular suitability of the theory for the development of efficient displacement plate elements are discussed. GRA

N90-18076# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

BASELINE EXPERIMENT FOR ACTIVE CONTROL OF STRUCTURAL VIBRATIONS M.S. Thesis

David R. Jacques Dec. 1989 121 p

(AD-A216194; AFIT/GAE/ENY/89D-15) Avail: NTIS HC A06/MF A01 CSCL 20/11

A baseline experiment is developed which can be used to evaluate control systems for large space structures. The experiment consists of an inverted cantilever beam. Proof mass actuators and a structural dynamics shaker provide the control forces, and integrated output of beam-mounted accelerometers provides velocity feedback. A programmable controller allows different control algorithms to be evaluated. System damping and frequency response are determined with and without the controller engaged, and experimental results are compared to analytical predictions. Modal suppression techniques are attempted in order to demonstrate active control of selected modes while maintaining overall system stability. GRA

N90-18077# Wisconsin Univ., Madison. Dept. of Engineering Mechanics.

ANALYSIS OF BIAXIAL STRESS FIELDS IN PLATES CRACKING AT ELEVATED TEMPERATURES Final Technical Report, 1 Jul. 1987 - 31 Aug. 1989

Stanley S. Balish, Neal F. Enke, Jon R. Lesniak, and Bela I. Sandor 19 Oct. 1989 149 p

(Grant AF-AFOSR-0253-87; AF Proj. 2302)

(AD-A216271; UW-88-127-029; AFOSR-89-1691TR) Avail: NTIS HC A07/MF A01 CSCL 11/6

Enhanced theories for thermographic stress analysis of isotropic and anisotropic materials are developed. These stress analysis techniques involve the measurement of the dynamic changes in temperature of a component undergoing dynamic loading. The enhanced theories presented allow for quantitative analyses of nonlinear thermoelastic and thermoplastic effects. A theory quantifying damage in anisotropic materials is also presented. From these analytical developments, several new applications for thermographic stress analysis are developed including residual stress analysis, cyclic plasticity analysis, and high-temperature stress analysis. A numerical method for separating the principal stresses is also developed. Examples of each of these applications are presented, and limitations for each are given. In particular, the principal problems encountered relating to high-temperature stress analysis are discussed at length. Residual stress analyses were performed on a C-shaped specimen of Ti-6Al-4V alloy, and the minimum resolvable residual stress was found to be 25 MPa. Cyclic plasticity analyses of 1020 steel and 6061-T6 aluminum were performed. The data obtained were found to be in qualitative agreement with the enhanced theory. GRA

N90-18078# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

FINITE ELEMENT INVESTIGATION OF A COMPOSITE CYLINDRICAL SHELL UNDER TRANSVERSE LOAD WITH THROUGH THICKNESS SHEAR AND SNAPPING M.S. Thesis

Kevin J. Silva Dec. 1989 136 p

(AD-A216377; AFIT/GAE/ENY/89D-35) Avail: NTIS HC A07/MF A01 CSCL 11/4

The static response of a circular cylindrical open shell (curved panel) constructed of an orthotropic graphite/epoxy laminate is numerically investigated in this thesis. The shell is subjected to an inward point load, centered on and normal to the shell surface, which maintains its original orientation through deformation (i.e., dead load). The shell displacement response is seen to vary widely with shell geometry and boundary conditions, not only in magnitude of deformation but also in the nature and progression of the collapse under critical load. The finite element analysis is conducted with a quasi-two-dimensional thin shell element which incorporates parabolic transverse shear stress through the thickness. The element can be formulated with either large displacement/rotation kinematics or the simpler Donnell relations. To enable tracking through critical load and displacement points and investigation of the post-critical regime, a solution algorithm other than the popular Newton-Raphson technique with displacement control or load control is required. The algorithm employed here uses a modified Riks/Wempner technique. It allows continuous tracing of the load - deflection response through critical load and critical displacement points. Step size is automatically scaled to follow the solution path closely in the areas of large load or displacement changes which surround critical points. GRA

N90-18079# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

INVESTIGATION OF COLLAPSE CHARACTERISTICS OF CYLINDRICAL COMPOSITE PANELS WITH LARGE CUTOUTS M.S. Thesis

Scott A. Schimmels Dec. 1989 318 p

(AD-A216378; AFIT/GAE/ENY/89D-33) Avail: NTIS HC A14/MF A01 CSCL 13/13

In order to better understand the collapse properties of composite shells, an analysis of cylindrical panels with large cutouts (11 to 17 percent of surface area) was conducted with two finite element codes (STAGSC-1 and SHELL). These results were then compared to experimental findings. Existence of cutout, eccentricity of cutout, boundary conditions, and panel width are varied to see how each affected the collapse load. In addition, the release of

residual strain due to placing the cutout within the panel was evaluated. It was found that placing a cutout in the panel and/or removing the vertical support reduced the total collapse load by at least 50 percent. Surface imperfections were seen to reduce the collapse load, but more importantly these imperfections accurately predicted the nonlinear response of the shell. STAGSC-1 accurately predicted the composite panels' response to axial compression. Transverse shear was seen to be important if the panels' free edges underwent 15 to 17 degree or more of rotation. Hence the SHELL program gave better results than STAGSC-1 for those panels that saw rotations greater than 17 deg. The residual stress test showed there was a measureable change in strain due to cutting the panel. However, the magnitude of this change is minimal when compared to the total collapse load of the shell. GRA

N90-18080# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
VALIDATION OF THE BOUNDARY ELEMENT METHOD APPLIED TO COMPLEX FRACTURE MECHANICS CONDITIONS M.S. Thesis
Ralph E. Urch Dec. 1989 157 p
(AD-A216412; AFIT/GAE/ENY/89D-39) Avail: NTIS HC A08/MF A01 CSCL 12/5

This thesis presents analyses of several fracture mechanics problems via the Boundary Element Method. Specifically, an indirect procedure known as the Displacement Discontinuity Method was used to solve problems involving cracks in isotropic or specially orthotropic materials. Infinite as well as finite regions were considered. A series of configurations were analyzed and compared with either analytic solutions or results from a finite element model. Agreement for the infinite-domain problems was excellent, while solutions to the finite-domain problems ranged from good to excellent. Advantages and disadvantages of the Displacement Discontinuity Method are briefly discussed. The main advantage of the method is the requirement to model only the boundary of the problem under consideration. The major disadvantage is the time required to solve the resulting fully-populated matrix equation. Separate FORTRAN codes are provided as appendices for the two material types - isotropic and orthotropic. These programs may be utilized for either stress or fracture analyses. Program outputs include displacements, stresses, and stress intensity factors, as appropriate. GRA

N90-18081*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
INTEGRATED FORCE METHOD VERSUS DISPLACEMENT METHOD FOR FINITE ELEMENT ANALYSIS
Surya N. Patnaik, Laszlo Berke, and Richard H. Gallagher (Clarkson Univ., Potsdam, NY.) Washington Feb. 1990 33 p
(NASA-TP-2937; E-4604; NAS 1.60:2937) Avail: NTIS HC A03/MF A01 CSCL 20K

A novel formulation termed the integrated force method (IFM) has been developed in recent years for analyzing structures. In this method all the internal forces are taken as independent variables, and the system equilibrium equations (EE's) are integrated with the global compatibility conditions (CC's) to form the governing set of equations. In IFM the CC's are obtained from the strain formulation of St. Venant, and no choices of redundant load systems have to be made, in constrast to the standard force method (SFM). This property of IFM allows the generation of the governing equation to be automated straightforwardly, as it is in the popular stiffness method (SM). In this report IFM and SM are compared relative to the structure of their respective equations, their conditioning, required solution methods, overall computational requirements, and convergence properties as these factors influence the accuracy of the results. Overall, this new version of the force method produces more accurate results than the stiffness method for comparable computational cost. Author

42 GEOSCIENCES (GENERAL)

N90-18082# Hawaii Univ., Honolulu. Inst. of Geophysics.
PARAMETERIZATION OF SMALL-SCALE PROCESSES
Peter Muller, ed. and Diane Henderson, ed. Sep. 1989 364 p Presented at the Hawaiian Winter Workshop, Manoa, HI, 17-20 Jan. 1989
(Contract N00014-89-J-1226)
(AD-A215507) Avail: NTIS HC A16/MF A02 CSCL 08/3

These proceedings contain the lectures given at the fifth, Aha Huliko, a Hawaiian Winter Workshop on the, Parameterization of Small Scale Processes, and a summary of the workshop, which appeared in EOS (Transactions, American Geophysical Union). The lectures and the summary cover the major aspects and issues of representing subgrid-scale mixing processes in oceanic general circulation models. GRA

43 EARTH RESOURCES AND REMOTE SENSING

Includes remote sensing of earth resources by aircraft and spacecraft; photogrammetry; and aerial photography.

For instrumentation see *35 Instrumentation and Photography.*

N90-18083# Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).
EUTROPHICATION ASSESSMENT THROUGH REMOTE SENSING TECHNIQUES
Evlyn Marcia LeaodeMoraesNovo and Moacir GodyJunior Sep. 1989 6 p Submitted for publication
(INPE-4932-PRE/1422) Avail: NTIS HC A02/MF A01

An experiment developed to incorporate TM/LANDSAT data into an eutrophication assessment system is presented. Barra Bonita reservoir (Sao Paulo State) was selected as test site mainly because it has a good conventional monitoring program against which the efficiency of the remote sensing monitoring system could be evaluated. Statistical analysis of the water quality index collected in the main tributaries of the reservoir allowed identification of winter time as the critic period in terms of the eutrophication. Three TM/LANDSAT sets were then obtained for the winter period in three different years: 1984, 1986 and 1988. Those data were digitally processed for reducing atmospheric and illumination variability among them. Changes in macrophyte population and water color were related to changes in water tropical level. Author

N90-18084# Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil). Ministerio de Ciencia e Tecnologia.
SPECTRAL RESPONSES OF SOYBEANS AND THEIR RELATIONSHIP WITH AGRONOMICAL PARAMETERS
Getulio TeixeiraBatista, Bernardo Friedrich T Rudorff, and Antonio Francisco P. Oviedo Jun. 1989 10 p In PORTUGUESE; ENGLISH summary Presented at the 5th Brazilian Symposium on Remote Sensing, Natal, Brazil, 11-15 Oct. 1988
(INPE-4832-PRE/1462) Avail: NTIS HC A02/MF A01

The spectral responses of two soybean varieties planted monthly (in a period of three months) and their relationship to percent ground cover, biomass, height, and yield were investigated. Bidirectional reflectance factor was measured throughout the growing period (five campaigns at 20 day interval, approximately) of six experimental plots of 5 x 10 m size (three plots of each variety planted at one month interval) using a 17 band (visible and NIR) portable radiometer. In each campaign, six measurements per plot were taken in order to obtain a representative estimate for the plot reflectance factor. Plant height and development stage were estimated concomitant to the radiometric measurements; biomass estimates were sampled three times per plot during specific development stages (flowering, grain filling and maturation) and total plot production was measured at harvest. The percent

ground cover was estimated through photographs taken simultaneously to the radiometric measurements. Results indicated that differences in reflectance between the two varieties correspond to differences in their biomass. However, in the visible peaked at 550 nm there is a slight difference between the two varieties. The ratio vegetation index explained close to 80 percent of the variation in the fresh biomass. This result is particularly important because these varieties are planted during the winter growing season for biomass production to be used for cattle feeding in the Paraiba river valley. Author

N90-18085# Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil). Ministerio de Ciencia e Tecnologia.
EVALUATION OF DIGITAL CLASSIFICATION RESULTS OF SUMMER CULTIVATION IN A TEST AREA IN THE PARANA-ANO STATE HARVEST 1986-1987
Mauricio AlvesMoreira and Sherry ChouChen Jun. 1989 8 p In PORTUGUESE; ENGLISH summary Presented at the 5th Brazilian Symposium on Remote Sensing, Natal, Brazil, 11-15 Oct. 1988
(INPE-4828-PRE/1459) Avail: NTIS HC A02/MF A01

LANDSAT-TM digital data were used an an auxiliary variable in addition to sampled field information to estimate summer crops using the approach of regression estimator. The test area in Parana State was covered by LANDSAT data of orbit 223, point 77 on February 10 of 1987 to train the computer classifier; field data of 120 sampled segments which represented the agricultural area according to their crop intensities were used. Field information of sampled segments were digitized and located on LANDSAT digital data using a digitizing table linked to the image analysis system SITIM-110 and the classification was carried out pixel-to-pixel using an algorithm based on Gaussian maximum likelihood decision rule. Study results show that: (1) the digitalization process was not satisfactory; (2) field boundaries and aerial photographs of 1981 were out-of-date and caused classification errors; (3) the lag between the dates of satellite pass and field data collection has negative impacts on the training process; and (4) the training system should be investigated more before applying the regression estimation. Author

N90-18086# Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil). Ministerio da Ciencia e Tecnologia.
STUDY OF ALTERATION COVERS OF PART OF THE SAO PAULO STATE THROUGH REMOTE SENSING DATA M.S. Thesis
Paulina SettiRiedel Jul. 1989 166 p In PORTUGUESE; ENGLISH summary
(INPE-4849-TDL/364) Avail: NTIS HC A08/MF A01

The relationship was studied between spatial and spectral characteristics of alteration covers in TM-LANDSAT imagery, channels 3, 4, and 7 with their chemical properties, as iron aluminum, titanium content and chemical alteration index; and their physical properties as porosity, plasticity limits, and liquidness limit, clay percentages and physical alteration index. The study was developed in a portion of state of Sao Paulo, between Rio Claro, Piracicaba, Limeira and Araras cities. The results led to the following conclusions: the weathering development, mainly the latossolization, acts as an landscape homogeneizer and turns it difficult to separate geological units through photointerpretation methods; the physical properties showed close relation with TM-LANDSAT imagery textures; the chemical properties evaluated through iron, aluminum and titanium content demonstrated that they change during alteration process and are related to the gray levels of alteration covers in TM-LANDSAT images. Author

N90-18087# Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil). Ministerio da Ciencia e Tecnologia.
THE USE OF PHOTOGRAPHS FOR IDENTIFICATION AND ANALYSIS OF URBAN RESIDENTIAL SECTORS, WITH PLANNING VIEWS Ph.D. Thesis
Maria deLourdesNevesdeOliveiraKurkdjian Jan. 1989 32 p In PORTUGUESE; ENGLISH summary Presented at the 2nd Latin American Symposium on Remote Sensing, Bogota, Colombia, 1987
(INPE-4788-PRE/1448) Avail: NTIS HC A03/MF A01

A method to define a geographical reference system to be used as a tool in urban analysis of residential areas and their population is presented. The procedures to be used in this analysis are also presented. The method preconizes the use of 1:10,000 panchromatic aerial photographs. Urban residential sectors are discriminated according to their photographical textures. Similar textures are combined into sectors so as to integrate the town spatial component into the urban diagnosis. The assumptions are: (1) the urban residential areas in Brazilian towns are differentiated according to social stratification; and (2) there is a strong relationship between physical aspects of these residential areas and socioeconomic features of their population. Those assumptions were tested in Sao Jose do Campos, S.P., Brazil. Survey data were submitted to Analysis of Variance and Cluster Analysis Techniques (ANOVA). The results supported the assumption of this work. Actually homogeneous textures found in aerial photographs can be used as a reliable criterion to identify urban population segments according to some of their social economic features. The results also support the proposed method. Author

N90-18088# Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil). Ministerio da Ciencia e Tecnologia.
REMOTE SENSING IN AGRICULTURE: BASIC CONCEPTS, METHODOLOGY AND APPLICATIONS
Antonio Roberto Formaggio, Antonio TebaldiTardin, Bernardo Friedrich T Rudorff, Getulio VargasdeAssuncao, Jose Carlos NEpiphanio, Mauricio AlvesMoreira, Sherry ChouChen, and Valdete Duarte Apr. 1989 229 p In PORTUGUESE; ENGLISH summary
(INPE-4806-MD/39) Avail: NTIS HC A11/MF A02

The objective of this training manual is to present the basic concepts, the methodologies, and the applications of remote sensing in the agriculture. It is divided in three basic approaches: the first presents the interactions of the electromagnetic radiation with plants, soils and canopies; the second presents the methodologies of acquisition and utilization of remote sensing data in the agriculture at field, aerial, and orbital levels and; the third approach presents the remote sensing projects developed at INPE, in the agricultural area and the projects realized in the USA like CBWE, LACIE, and AgRISTARS. Author

N90-18089# Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil). Ministerio da Ciencia e Tecnologia.
INTERNATIONAL COURSE IN REMOTE SENSING ONU/INPE, BRAZIL
Tania Maria Sausen Mar. 1989 15 p In PORTUGUESE; ENGLISH summary
(INPE-4802-NTE/288) Avail: NTIS HC A03/MF A01

The Institute for Space Research (INPE) is a Brazilian research and development organization working for more than 15 years with Remote Sensing. One of INPE's main concern is the transference of technology different users in Brazil and abroad. This is done through master degree programs and long term training courses such as the International course on Remote Sensing held at INPE. This course is offered by Brazilian Government, in cooperation with INPE, to the Space Application Division of United Nations Organization-UNO. The objective of this course is to qualify experts from developing countries in remote sensing research and techniques for surveying and monitoring of natural resources. The course is designed for Latin-American and African specialists, and two courses were held. The third International Course will be conducted from March to August 1989 and will be designed for Latin-American specialists. This work presents the history, program, facilities, and future perspectives of the course. Author

N90-18090# Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil). Ministerio da Ciencia e Tecnologia.
PROPOSITION FOR AN AIRBORNE REMOTE SENSING SYSTEM
Roberto PereiradaCunha, Marcus Antonius AndradeSiqueira,

Amauri SilvaMontes, Alderico RodriguesdePaulaJunior, and Jose Carlos Moreira Aug. 1989 16 p In PORTUGUESE; ENGLISH summary Presented at the 3rd Brazilian Symposium on Remote Sensing, Rio de Janeiro, Brazil, 28-30 Nov. 1984
(INPE-4872-PRE/1483) Avail: NTIS HC A03/MF A01

An airborne data acquisition system for remote sensing purposes is described. This system includes three CCD-cameras, one electro-optical mechanical scanner, data processing, recording, and display subsystems. The data acquisition system is designed for both research and applications in remote sensing and includes versatile and fast operations on data acquisition; among them, thematic mapper-like, smart sensor, imaging-spectrometer, and real time imaging configurations. The flexibility of this airborne data acquisition system permits the interaction of the user in the planning of the parameters of remote sensing missions. Author

N90-18091# Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil). Ministerio de Ciencia e Tecnologia.
LANDSAT-TM AND AGROMETEOROLOGICAL DATA IN THE WHEAT CROP YIELD ESTIMATION AT THE FARM LEVEL
Bernardo Friedrich T Rudorff and Getulio TeixeiraBatista May 1989 8 p In PORTUGUESE; ENGLISH summary Presented at the 5th Brazilian Symposium on Remote Sensing, Natal, Brazil, 11-15 Oct. 1988 Sponsored by Banco de Brazil
(INPE-4842-PRE/1471) Avail: NTIS HC A02/MF A01

Wheat plays an important role in the Brazilian production. Therefore, objective and reliable methods for yield estimation are needed especially at the farm level where several management actions have to be taken. LANDSAT-TM and agrometeorological data were integrated in order to obtain a model for wheat yield estimation at the farm level for a test site in the south of Sao Paulo State. LANDSAT data for the crop years of 1986 (three acquisitions) and 1987 (two acquisitions), agronomic and meteorological data were related to yield estimates at the field level (250 fields approximately). Results have shown that vegetation index derived from LANDSAT-TM explained 64 and 46 percent of wheat yield variability for the two crop years analyzed. The joint use of both vegetation index and agrometeorological data in a single model improved the results to 71 and 53 percent respectively for the crop year of 86 and 87. The proposed model is to be validated for future crop seasons nevertheless it provided objective and accurate results for wheat estimation on the two crop seasons analyzed. Author

N90-18092# Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil). Ministerio de Ciencia e Tecnologia.
AERIAL PHOTOGRAPHS TO SUPPORT THE FISCALIZATION PROCESS OF AGRICULTURE LOANS IN THE IRECE-BA REGION
Bernardo Friedrich T Rudorff and Antonio TebaldiTardin Jun. 1989 12 p In PORTUGUESE; ENGLISH summary Presented at the 5th Brazilian Symposium on Remote Sensing, Natal, Brazil, 11-15 Oct. 1988 Sponsored by Banco de Brazil
(INPE-4839-PRE/1468) Avail: NTIS HC A03/MF A01

The objective was to support the fiscalization process of governmental loans for agriculture using aerial photographs. The target area was located in Bahia State and comprised the municipal areas of Irece, Lapao, Gabriel, and Joao Dourado. For monitoring the proper use of agricultural loans provided by Banco do Brasil S/A (Bank of Brazil), aerial photographs were used in a first phase after the plowing or at crop emergence state and in a second phase before harvesting. Vertical aerial photographs were obtained in color prints at the scale of 1:30,000 and 1:15,000, respectively for the first and second phases of this work. The farms which were granted with loads were outlined over the aerial photographs using cadastral maps at the scale of 1:5,000 and 1:25,000. The aerial photographs obtained in the first phase of the work were used to assess the area of soil prepared for planting and it was possible to assess 92 percent of the farms of which 27.20 percent presented area reduction when compared to the area agreed to be planted in the loan contract. For the second phase the aerial photographs were utilized both to identify the crop and to evaluate the planted area in accordance with the loan contract. In this phase 50 percent of the loan contracts were analyzed of which 27.68 percent were in irregular situation in relation to planted crop or area reduction. From the aircraft flight mission to the delivery of results to the local agency of Bank of Brazil 15 and 20 days, respectively were spend for the first and second phase of the work. This work showed that from a technical point of view the operational loan fiscalization is possible to be done using aerial photographs in the region of Irece. The economic feasibility of utilization of remote sensing techniques as an auxiliary tool in an operational form to the process of agricultural loan control was showed in the coast analysis. Author

N90-18093# Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil). Ministerio da Ciencia e Tecnologia.
USE OF BETA-SPLINES FOR DIGITAL ELEVATION MODELING
Luiz Alberto VieiraDias, Eunildes M. Quintan (Instituto Tecnologico de Aeronautica, Sao Jose dos Campos, Brazil), and Carlos Eduardo Nery Sep. 1989 7 p In PORTUGUESE; ENGLISH summary Presented at the 14th Brazilian Conference on Cartography, Gremado, Brazil, 26-28 May 1988
(INPE-4941-PRE/1431) Avail: NTIS HC A02/MF A01

Digital elevation models are becoming a very powerful tool for mapping. One of the frequently occurring problems is that, due to the lack of information or bad control grid point choice, the interpolation to density the model may not be faithful to the reality. A comparison is made between a bilinear interpolation and the use of beta-splines. In spite of the additional computational effort, the beta-spline presents superior results, since it is possible to force the surface curvature through the beta 1 and beta 2 parameters, which control the bias and the tension of the interpolated surface. Author

N90-18094# Orincon Corp., La Jolla, CA.
REMOTE SENSING: ENVIRONMENTAL EFFECTS OF SURFACE FILMS Final Report
12 Dec. 1989 21 p
(Contract N00014-87-C-0476)
(AD-A216190; OCR-89-U-0352) Avail: NTIS HC A02/MF A01 CSCL 08/3

This report describes a portion of a program involving both experimental and theoretical studies of the influences of natural biogenic sea surface films on air-sea interfacial parameters. In addition, the role of physical processes in the marine environment on the film's state, lifetime, and transport is being investigated. Initial objectives included the determination of the effects of: (1) currents on film formation and intensity, (2) surface films on waves, (3) surface films on wave/current interactions, and (4) surface films on near-surface turbulence. During the planning of the program these objectives were refined to emphasize the following specific subject areas: (1) Film transport and modulation by currents; Film involvement in wave-induced Langmuir instability; and (3) Film effects on sensible temperature including the determination of T as a function of the surface elastic modulus, and the time scales involved in the development of the temperature effects. GRA

44 ENERGY PRODUCTION AND CONVERSION

Includes specific energy conversion systems, e.g., fuel cells; global sources of energy; geophysical conversion; and windpower.

For related information see also *07 Aircraft Propulsion and Power, 20 Spacecraft Propulsion and Power,* and *28 Propellants and Fuels.*

N90-18095# Geological Survey of Japan, Ibaraki.
MID-TERM REPORT ON-THE STUDY AND DEVELOPMENT RESULTS OF THE SUNSHINE PROJECT IN FISCAL 1987. STUDY ON THE EVALUATION TECHNOLOGY OF GEOTHERMAL SOURCES IN JAPAN

Oct. 1988 124 p In JAPANESE
(DE90-710708; GSJ-8902) Avail: NTIS (US Sales Only) HC A06/MF A01

Study results of the evaluation technology of geothermal sources in Japan in fiscal 1987 were collected as a part of the Sunshine Project. To study the evaluation of geothermal sources on the scale of great sphere, investigations and re-examinations were carried out. In South Kyushu, geological study on the area whose first stage of the volcanic layers are not yet known was executed. In the reinvestigation of the Hakkoda geothermal area, the anisotropy of the apparent specific resistance was explained by the great sphere MT method. The changes of the volcanic activities confirmed in the middle Kyushu will be effective information of the plate movements after 5Ma. The magma reservoir that burst the Kinugawa welded pyroclastic rocks is already cold as a source of heat. A new method of evaluating geothermal sources was studied next. In the Hakkoda geothermal area, the heat sources, the geothermal reservoir layer and the geothermal fluidic system are closely related with the caldera, and so a matching model was created. And the enumerated amount of geothermal sources showed a reasonable value. The specific resistance distribution obtained by the MT method indicated the distribution of layers well. Existing data were collected and the interpretation standard was created as the base of learnings for extracting promising geothermal areas. DOE

N90-18096# Bonneville Power Administration, Portland, OR. Office of Conservation and Power Resources.
PERFORMANCE PREDICTIONS FOR PASSIVE SOLAR WATER HEATING SYSTEMS. REPORT 1: PERFORMANCE MONITORING TO VALIDATE SITE-SPECIFIC ESTIMATES OF PASSIVE SOLAR WATER HEATERS. REPORT 2: LABORATORY REPORT. PASSIVE SOLAR WATER HEATER TESTS
David Robinson (Department of Energy, Portland, OR.) and Ken Martin May 1988 158 p
(Contract DE-AI79-83BP-13449)
(DE90-002879; DOE/BP-13449/1) Avail: NTIS HC A08/MF A01

The two reports included in this publication describe work done to validate performance prediction procedures and test methods for passive solar domestic hot water systems. The reports assess established prediction procedures and investigate the validity of testing techniques. The intent is to develop methodologies for passive solar systems at a level similar to that already in place for active solar systems. DOE

N90-18097*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
CHANGES IN IMPEDANCE OF Ni ELECTRODES UPON STANDING AND CYCLING
Margaret A. Reid 1989 16 p Presented at the 1989 Fall Meeting of the Electrochemical Society, Hollywood, FL, 15-20 Oct. 1989
(NASA-TM-102438; E-5207; NAS 1.15:102438) Avail: NTIS HC A03/MF A01 CSCL 10A

Impedances of Ni electrodes vary with many factors including voltage, cycling, and manufacturer. However, results from Ni/H2 cells being tested for Space Station Freedom show that consistent results are obtained within a group of cells from the same manufacturer if the cells are cycled and stored in the same manner. Impedance changes with storage and cycling are being investigated. Impedances are low in the fully charged state but rise abruptly by several orders of magnitude at a voltage corresponding to a very low state-of-charge. After standing for several months, this increase occurred at a higher voltage, consistent with an increase in structural order during storage which hinders diffusion of protons and reduces high rate capacity. Early measurements on the effects of cycling on Ni/H2 cells being tested for Space Station Freedom show differences between cells from different manufacturers. Author

N90-18098# Minnesota Univ., Minneapolis.
PERFORMANCE OF SUPERCONDUCTIVE OXIDES AS CATHODES FOR LITHIUM RECHARGEABLE BATTERIES Technical Report, Jul. 1988 - Oct. 1989
B. B. Owens, M. Z. A. Munshi, P. S. S. Prasad, W. H. Smyrl, W. Kinzy Jones, J. B. Schlenoff, and H. F. Wu 23 Oct. 1989 3 p
(Contract N00014-88-K-0360)
(AD-A216030; TR-18-ONR) Avail: NTIS HC A01/MF A01 CSCL 10/3

The superconducting oxides, yttrium barium copper oxide and neodymium copper oxide were fabricated into cathodes for lithium nonaqueous batteries. The cathode limited cells had electrolytes of 1M LiClO4 or LiAsF6 in propylene carbonate or 2-methyl-tetrahydrofuran and were hermetically sealed in stainless steel case-positive cans. The initial open circuit potentials were in the range of 3.0 to 3.5 volts for all cell types. The potentials of both types of cells with oxides prepared in an atmosphere of O2 were about 200mV greater than those for cathodes that were prepared in an N2 atmosphere. Cycle and capacity test results are presented. GRA

N90-18099# Minnesota Univ., Minneapolis.
APPLICATION OF POLYMER ELECTROLYTES TO LITHIUM BATTERIES Technical Report, Jul. 1988 - Oct. 1989
B. B. Owens, M. Z. A. Munshi, and P. S. S. Prasad 23 Oct. 1989 3 p
(Contract N00014-88-K-0360)
(AD-A216038; TR-19-ONR) Avail: NTIS HC A01/MF A01 CSCL 10/3

Ever since the publication of Fenton and Wright's work on ionically conducting polymers in 1973, the potential application of solid polymer electrolytes to solid state lithium batteries has lead to an extensive investigation of their transport and electrochemical properties. Recent modeling studies on lithium/insertion cathode cells, including the design scale-up for both unipolar and bipolar configurations indicates the possibility of achieving high energy and power densities well in excess of the present advanced batteries. The recently reported work on polymer electrolyte batteries that operate from -20 C to +100 C demonstrates the utility of this new class of lithium batteries. GRA

N90-18100# Texas A&M Univ., College Station. Center for Electrochemical Systems and Hydrogen Research.
A LIGHTWEIGHT SOLID POLYMER ELECTROLYTE FUEL CELL WITH STACK POWER DENSITY OF 3kW/lb (7 kW/kg) End of the Year Report
A. John Appleby 1989 10 p
(Contract N00014-88-K-0389)
(AD-A216253) Avail: NTIS HC A02/MF A01 CSCL 10/3

The performances of solid polymer electrolyte fuel cells were evaluated by recording their half/single cell potential vs. current density data. A schematic of the single cell assembly is shown. Half and single cell potential vs. current density plots for a single cell using platinum-sputtered electrodes and Dow membrane are also shown. This data represents the best performance (0.62 V at 2 A/sq cm) attained in single cells with low platinum loading electrodes. The performance of this cell is compared with the performances of single cells using Nafion membranes of two different thicknesses. It shows that the cell potential vs. current density plots almost overlap in the low current density region (say up to 50 mV). This means that the action-controlled behavior is unaffected by the characteristics of the membrane (Dow vs. Nafion, Nafion thick vs. thin). This result can be interpreted on the basis that the electrochemical reaction occurs to a large extent within the pores on the surfaces of the electrodes which are coated with Nafion in all the single cells. With increasing current density, the role of the membrane (type, thickness) is dominant and consequently the slopes of the linear region are different. GRA

N90-18101# Energy Conversion Devices, Inc., Troy, MI.
RESEARCH ON HIGH-EFFICIENCY, MULTI-GAP, MULTI-JUNCTION AMORPHOUS SILICON-BASED ALLOY THIN-FILM SOLAR CELLS Annual Subcontract Report, 1 Mar. 1988 - 28 Feb. 1989
S. Guha, A. Bannerjee, J. Burdick, E. Chen, T. Glatfelter, G. Hammond, M. Hopson, T. Laarman, M. Lycetter, and R. Mohr et al Oct. 1989 93 p
(Contract DE-AC02-83CH-10093)
(DE89-009492; SERI/STR-211-3581) Avail: NTIS HC A05/MF A01

This research program is directed toward the advancement of understanding of amorphous silicon-based alloys and their use in small area multi-junction solar cells. The principal objectives of the program are: (1) to develop a broad scientific base for the chemical, structural, optical and electronic properties of amorphous silicon-based alloys; (2) to determine the optimum properties of these alloy materials as they relate to high efficiency cells; (3) to determine the optimum device configuration for multi-junction cells; and (4) to demonstrate by the end of February, 1990 the proof-of-concept multi-junction amorphous silicon alloy-based solar cells having an efficiency of 16 percent under standard global AM1.5 solar insolation conditions and having an area of at least 1 sq cm. DOE

N90-17713# Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires.
SOLID POLYMER ELECTROLYTE WATER ELECTROLYSIS AS A MEAN OF ENERGY STORAGE FOR SPACE APPLICATIONS
P. Millet, T. Alleau, P. Mathonnet, M. Pineri, and R. Durand (Centre de Recherche en Electrochimie Minerale et en Genie des Procedes, Saint Martin-d'Heres, France) *In* ESA, European Space Power, Volume 1 Aug. 1989 p 245-249 (For primary document see N90-17678 10-20)
Copyright Avail: NTIS HC A19/MF A03

N90-17719# Dornier System G.m.b.H., Friedrichshafen (Germany, F.R.).
OPTIMIZED SENSIBLE HEAT STORAGE SYSTEMS FOR APPLICATION TO SOLAR DYNAMIC POWER GENERATION
W. J. Denner, A. A. Fritzsche, and P. Jany *In* ESA, European Space Power, Volume 1 Aug. 1989 p 281-286 (For primary document see N90-17678 10-20)
Copyright Avail: NTIS HC A19/MF A03

N90-17720# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Stuttgart (Germany, F.R.). Inst. fuer Technische Thermodynamik.
DEVELOPMENT OF A HIGH TEMPERATURE STORAGE UNIT FOR INTEGRATION WITH SOLAR DYNAMIC SYSTEMS
H. J. Staehle and F. Lindner *In* ESA, European Space Power, Volume 1 Aug. 1989 p 287-291 (For primary document see N90-17678 10-20)
Copyright Avail: NTIS HC A19/MF A03

N90-17749# Centre National de la Recherche Scientifique, Valbonne (France). Lab. de Physique du Solide et Energie Solaire.
Ga0.47In0.53As CELLS FOR GaAs-STACKED PHOTOVOLTAIC TANDEMS
B. Beaumont, P. Garabedian, G. Nataf, J.-C. Guillaume, and C. Verie *In* ESA, European Space Power, Volume 2 Aug. 1989 p 489-493 Sponsored by PIRSEM-CNRS; AFME; and Euro GaAs PV Federation (For primary document see N90-17748 10-20)
Copyright Avail: NTIS HC A16/MF A03

N90-17750# Centre National de la Recherche Scientifique, Valbonne (France). Lab. de Physique du Solide et Energie Solaire.
GaAs CELLS ON Si SUBSTRATES: A NEW CHALLENGE FOR SPACE PHOTOVOLTAIC APPLICATIONS
A. Freundlich, M. Leroux, J. C. Grenet, A. Saletes, G. Neu, A. Leycuras, J. Massies, P. Gibart, and C. Verie *In* ESA, European Space Power, Volume 2 Aug. 1989 p 495-499 Sponsored by the French Agency for Energy Measurements and the Commission of the European Communities (For primary document see N90-17748 10-20)
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N90-17751# Centro Informazioni Studi Esperienze, Milan (Italy).
ON-ORBIT DEMONSTRATION OF GaAs SOLAR CELL AND PANEL TECHNOLOGIES
C. Flores, F. Paletta, L. Brambilla, A. Caon, R. Contini, R. Gajo, E. Rossi, C. Signorini, and R. L. Crabb *In* ESA, European Space Power, Volume 2 Aug. 1989 p 501-506 Prepared in cooperation with Fabrica Italiana Apparecchiature Rafioelettriche, Milan, Italy and ESTEC, Noordwijk, Netherlands (For primary document see N90-17748 10-20)
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N90-17752# Centro Informazioni Studi Esperienze, Milan (Italy).
ADVANCED GaAs SPACE SOLAR CELLS BY MOCVD TECHNIQUE
C. Flores, D. Passoni, and G. Timo *In* ESA, European Space Power, Volume 2 Aug. 1989 p 507-510 (For primary document see N90-17748 10-20)
Copyright Avail: NTIS HC A16/MF A03

N90-17753# Energies Nouvelles et Environnement S.A., Brussels (Belgium).
FABRICATION OF ULTRA THIN GaAs AND Ge SUBSTRATES FOR HIGH EFFICIENCY SOLAR CELLS
G. R. Smekens, Ph. Lauwers, P. Maes, and Ph. Lievens *In* ESA, European Space Power, Volume 2 Aug. 1989 p 511-513 (For primary document see N90-17748 10-20)
(Contract ESA-7616/88/N2/1W)
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N90-17754*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
GaAs SOLAR CELLS WITH V-GROOVED EMITTERS
S. G. Bailey, N. Fatemi, D. M. Wilt, G. A. Landis, and R. D. Thomas *In* ESA, European Space Power, Volume 2 Aug. 1989 p 515-518 (For primary document see N90-17748 10-20)
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N90-17755# Escuela Tecnica Superior de Ingenieros Aeronauticos, Madrid (Spain). Inst. de Energia Solar.
AlGaAs/GaAs SOLAR CELLS WITH EFFICIENCIES GREATER THAN 22 PERCENT
C. Algora, G. L. Araujo, A. Marti, and L. Mayet (Institut National des Sciences Appliquees de Lyon, Villeurbanne, France) *In* ESA, European Space Power, Volume 2 Aug. 1989 p 519-523 Sponsored in part by Instituto Nacional de Tecnica Aeroespacial (For primary document see N90-17748 10-20)
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N90-17756# English Electric Valve Co. Ltd., Chelmsford (England).
GaAs SPACE SOLAR CELLS: PILOT PRODUCTION EXPERIENCE USING A MULTI WAFER INFINITE MELT LIQUID PHASE EPITAXY PROCESS
T. A. Cross, J. Burrage, C. Hardingham, and A. Potts *In* ESA, European Space Power, Volume 2 Aug. 1989 p 525-529 Sponsored by the Ministry of Defence, London, England and the Dept. of Trade and Industry, London, England (For primary document see N90-17748 10-20)
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N90-17757# Newcastle-upon-Tyne Univ. (England). Dept. of Physics.
RADIATION EFFECTS IN ITO/InP SOLAR CELLS
N. M. Pearsall, N. Robson, I. Forbes, R. Hill, and C. Goodbody (Royal Aerospace Establishment, Farnborough, England) *In* ESA, European Space Power, Volume 2 Aug. 1989 p 531-536

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N90-17758*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
INDIUM PHOSPHIDE SOLAR CELL RESEARCH IN THE UNITED STATES: COMPARISON WITH NON-PHOTOVOLTAIC SOURCES
I. Weinberg, C. K. Swartz, and R. E. Hart, Jr. *In* ESA, European Space Power, Volume 2 Aug. 1989 p 537-542 Previously announced as N89-27868 (For primary document see N90-17748 10-20)
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N90-17760# Technische Univ., Berlin (Germany, F.R.). Inst. fuer Raumflug- und Reaktortechnik.
STRUCTURAL AND OPERATIONAL ASPECTS OF THE CONCENTRATING SARA-LOUVER SOLAR GENERATOR
K. D. Bunte, D. Rex, S. Wuebker, and W.-D. Ebeling (Erno Raumfahrttechnik G.m.b.H. Bremen, Germany, F.R.) *In* ESA, European Space Power, Volume 2 Aug. 1989 p 549-556 (For primary document see N90-17748 10-20)
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N90-17761# Nippon Electric Co. Ltd., Kanagawa (Japan).
SFU SOLAR ARRAY
Y. Shibayama, H. Arai, K. Matsui, K. Hama, A. Ushirokawa, M. Natori, K. Takahashi, N. Wakasugi, and T. Anzai (Institute for Unmanned Space Experiments Free Flyer, Tokyo, Japan) *In* ESA, European Space Power, Volume 2 Aug. 1989 p 557-562 Sponsored by the New Energy and Industrial Technology Development Organization (For primary document see N90-17748 10-20)
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N90-17762# Centre National d'Etudes Spatiales, Toulouse (France).
THE GSR3: A NEW APPROACH FOR SOLAR ARRAY DEPLOYMENTS
A. Mamode, D. Gangloff, and J. L. Bastard (Aerospatiale, Cannes, France) *In* ESA, European Space Power, Volume 2 Aug. 1989 p 563-567 (For primary document see N90-17748 10-20)
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N90-17763# Centre National d'Etudes Spatiales, Toulouse (France).
DEPLOYMENT SIMULATION FOR THE THIRD GENERATION SOLAR ARRAYS GSR3
A. Mamode, E. Conde, C. Verne, M. Rouchon, and J. L. Bastard (Aerospatiale, Cannes, France) *In* ESA, European Space Power, Volume 2 Aug. 1989 p 569-572 (For primary document see N90-17748 10-20)
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N90-17764# Fokker B.V., Amsterdam (Netherlands). Solar Array Mechanism Group.
SOLAR ARRAY DESIGNS FOR COLUMBUS ELEMENTS
Henk J. Cruijssen *In* ESA, European Space Power, Volume 2 Aug. 1989 p 573-584 (For primary document see N90-17748 10-20)
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N90-17765# AEG-Telefunken, Wedel (Germany, F.R.).
A LOW COST ANTICHARGING CONNECTION SYSTEM FOR SOLAR GENERATORS AND ITS APPLICATION ON ASPERA SOLAR ARRAY
Juergen W. Koch *In* ESA, European Space Power, Volume 2 Aug. 1989 p 587-590 (For primary document see N90-17748 10-20)
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N90-17766# AEG-Telefunken, Wedel (Germany, F.R.).
ULTRASONIC AND PARALLEL GAP WELDING OF GaAs SOLAR CELLS, EXPERIMENTAL AND SIMULATION RESULTS
S. Reul and W. Snakker *In* ESA, European Space Power, Volume 2 Aug. 1989 p 591-596 (For primary document see N90-17748 10-20)
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N90-17767# Aerospatiale, Cannes (France).
THE ISO SOLAR GENERATOR: SOLAR CELLS AND OSR MIXED
J. C. Chiarini *In* ESA, European Space Power, Volume 2 Aug. 1989 p 597-600 (For primary document see N90-17748 10-20)
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N90-17768# Allgemeine Elektrizitaets-Gesellschaft, Wedel (Germany, F.R.).
DESIGN DEVELOPMENT AND QUALIFICATION OF A SOLAR ARRAY WITH OSRS (SSM) BONDED TO THE ISO SPACECRAFT RIGID SUNSHIELD
J. Schmidt-zurBorg and B. Wodke *In* ESA, European Space Power, Volume 2 Aug. 1989 p 601-606 (For primary document see N90-17748 10-20)
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N90-17769# Pilkington Bros. Ltd., Ormskirk (England).
DIRECT GLASSING OF SILICON SOLAR CELLS
P. A. White, R. L. Crabb, and A. A. Dollery (European Space Agency. European Space Research and Technology Center, ESTEC, Noordwijk, Netherlands) *In* ESA, European Space Power, Volume 2 Aug. 1989 p 607-611 (For primary document see N90-17748 10-20)
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N90-17770# Allgemeine Elektrizitaets-Gesellschaft, Wedel (Germany, F.R.).
A CONCEPT OF A PILOT PRODUCTION PLANT FOR DIRECTLY GLASSED SILICON
Juergen W. Koch and Gerd Neuhaeusser *In* ESA, European Space Power, Volume 2 Aug. 1989 p 613-615 Sponsored in part by ESA/ESTEC (For primary document see N90-17748 10-20)
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N90-17771# European Space Agency. European Space Research and Technology Center, ESTEC, Noordwijk (Netherlands).
DEVELOPMENT OF AN ALUMINIUM SOLAR CELL INTERCONNECTOR TECHNOLOGY
J. C. Larue and Uwe Hoffmann (Allgemeine Elektrizitaets-Gesellschaft, Wedel, Germany, F.R.) *In its* European Space Power, Volume 2 Aug. 1989 p 617-621 (For primary document see N90-17748 10-20)
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N90-17772# Mitsubishi Electric Corp., Hyogo (Japan).
ASSEMBLY TECHNOLOGY OF GaAs SOLAR CELL
H. Matsumoto, S. Yoshida, T. Oda, M. Okubo, and Y. Okawa (Mitsubishi Electric Corp., Kamakura, Japan) *In* ESA, European Space Power, Volume 2 Aug. 1989 p 623-627 (For primary document see N90-17748 10-20)
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N90-17773# Allgemeine Elektrizitaets-Gesellschaft, Wedel (Germany, F.R.).
MANUFACTURE AND TESTING OF A SOLAR PANEL ASSEMBLY COMPRISING BIFACIAL SOLAR CELLS (AMOC-SPA)
Uwe Hoffmann and Juergen W. Koch *In* ESA, European Space Power, Volume 2 Aug. 1989 p 629-634 Sponsored by ESA/ESTEC (For primary document see N90-17748 10-20)
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N90-17774# Allgemeine Elektrizitaets-Gesellschaft, Wedel (Germany, F.R.).
TEMPERATURE MEASUREMENT DURING WELDING OF SOLAR CELLS AND CALIBRATION OF FINITE ELEMENT MODELS
S. Reul and H. Broeker *In* ESA, European Space Power, Volume 2 Aug. 1989 p 635-640 Sponsored by ESA/ESTEC (For primary document see N90-17748 10-20)
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N90-17776# Messerschmitt-Boelkow-Blohm G.m.b.H., Ottobrunn (Germany, F.R.).
ASSESSMENT OF SOLAR CELL QUALITY CRITERIA
G. J. LaRoche *In* ESA, European Space Power, Volume 2 Aug. 1989 p 647-652 (For primary document see N90-17748 10-20)
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N90-17778# Solarex Corp., Rockville, MD. Aerospace Div.
REDUCTION OF 50 MICRON THICK SOLAR CELL WEIGHT BY SELECTIVE BACK CONTACT SILVER PLATING
Joseph B. Creager and Edward M. Gaddy *In* ESA, European Space Power, Volume 2 Aug. 1989 p 659-662 (For primary document see N90-17748 10-20)
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N90-17780# Telefunken Electronic G.m.b.H., Heilbronn (Germany, F.R.).
PILOT PRODUCTION OF 70 MICRON THIN SILICON SOLAR CELLS
K.-D. Rasch, R. Schilling, K.-H. Tentscher, and K. Bogus (European Space Agency. European Space Research and Technology Center, ESTEC, Noordwijk, Netherlands) *In* ESA, European Space Power, Volume 2 Aug. 1989 p 669-673 (For primary document see N90-17748 10-20)
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N90-17781# Centre National de la Recherche Scientifique, Villeurbanne (France). Lab. de Physique du Solide et Energie Solaire.
GaAs BACK POINT CONTACT SOLAR CELL SIMULATION
B. Fofana (Universite Nationale de Cote d'Ivoire, Abidjan.), B. Beaumont, B. Bensaid, F. Raymond, J. C. Guillaume, and C. Verie *In* ESA, European Space Power, Volume 2 Aug. 1989 p 677-683 (For primary document see N90-17748 10-20)
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N90-17782# Messerschmitt-Boelkow-Blohm G.m.b.H., Ottobrunn (Germany, F.R.).
THE INMARSAT-2 SOLAR GENERATOR PANELS
L. Preuss *In* ESA, European Space Power, Volume 2 Aug. 1989 p 685-688 (For primary document see N90-17748 10-20)
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N90-17783# Messerschmitt-Boelkow-Blohm G.m.b.H., Ottobrunn (Germany, F.R.).
A PULSED SOLAR SIMULATOR FOR ELECTRICAL PERFORMANCE TESTS OF SPACE SOLAR CELLS/ARRAYS
W. Lukschal and A. P. Robben (European Space Agency. European Space Research and Technology Center, ESTEC, Noordwijk, Netherlands). *In* ESA, European Space Power, Volume 2 Aug. 1989 p 689-693 (For primary document see N90-17748 10-20)
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N90-17784# Universidad Politecnica de Madrid (Spain). Inst. de Energia Solar.
LIMITS OF EFFICIENCY OF SOLAR CELLS UNDER AMO-SPECTRUM ILLUMINATION: COMPARISON BETWEEN Si AND GaAs CELLS
G. L. Araujo and A. Marti *In* ESA, European Space Power, Volume 2 Aug. 1989 p 695-700 Sponsored by the Spanish Comision Interministerial de Ciencia y Tecnologia (For primary document see N90-17748 10-20)
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N90-17785# Pilkington P.E. Ltd., Bodelwyddan (Wales).
SOLAR CELL COVERGLASSES WITH ENHANCED THERMAL AND MECHANICAL PROPERTIES
A. M. Head *In* ESA, European Space Power, Volume 2 Aug. 1989 p 701-706 Sponsored in part by RAE and INTELSAT (For primary document see N90-17748 10-20)
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N90-17786# Fokker Space and Systems, Amsterdam (Netherlands).
STRUCTURAL DESIGN OF THE TELECOM 2 SOLAR ARRAY
L. C. M. vanLent *In* ESA, European Space Power, Volume 2 Aug. 1989 p 707-713 (For primary document see N90-17748 10-20)
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N90-17787# Aerospatiale, Cannes (France).
THE ITALSAT SOLAR ARRAY
G. Giacometti, G. A. Martin, W. Schultze, and K. Ribbe (Messerschmitt-Boelkow-Blohm G.m.b.H., Ottobrunn, Germany, F.R.) *In* ESA, European Space Power, Volume 2 Aug. 1989 p 715-719 (For primary document see N90-17748 10-20)
Copyright Avail: NTIS HC A16/MF A03

N90-17788# Sharp Corp., Nara (Japan).
CIC TYPE THIN DIODE FOR SOLAR ARRAY
K. Kamimura, Y. Tonomura, H. Yoshioka, Y. Uchida, Y. Kiyota, T. Matsutani, A. Suzuki, S. Ikegami, H. Arai, and K. Murata (Nippon Electric Co. Ltd., Kanagawa, Japan) et al *In* ESA, European Space Power, Volume 2 Aug. 1989 p 721-726 (For primary document see N90-17748 10-20)
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N90-17789# Aix-Marseilles Univ. (France). Lab. de Photoelectricite.
INVESTIGATIONS ON HOT SPOTS EFFECTS IN REVERSE BIASED SPATIAL SOLAR CELLS
J. P. David, J. Duveau, J. Guerin, A. Naamane, S. Noureddine, A. Michel, E. Rapp, and M. Roussel (Centre National d'Etudes Spatiales, Toulouse, France) *In* ESA, European Space Power, Volume 2 Aug. 1989 p 727-733 (For primary document see N90-17748 10-20)
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N90-17790# MATRA Espace, Toulouse (France).
NEW MODELS AND TECHNIQUES FOR PREDICTING RADIATION EFFECTS ON SOLAR ARRAY PERFORMANCES
J. P. Estienne and J. G. Ferrante *In* ESA, European Space Power, Volume 2 Aug. 1989 p 735-740 (For primary document see N90-17748 10-20)
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N90-17791# Aerospatiale, Cannes (France).
SOLAR CELL ELECTRODYNAMIC CHARACTERISTICS TEST EQUIPMENT
M. Coustal and Ph. Samson *In* ESA, European Space Power, Volume 2 Aug. 1989 p 741-744 (For primary document see N90-17748 10-20)
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N90-17800# Solarex Corp., Rockville, MD. Aerospace Div.
LIGHTWEIGHT, LOW COST, THIN SILICON CELL ARRAYS
R. Dominguez and L. Slifer *In* ESA, European Space Power, Volume 2 Aug. 1989 p 795-800 (For primary document see N90-17748 10-20)
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N90-17802# Physikalisch-Technische Studien G.m.b.H., Freiburg (Germany, F.R.).
SOLAR ARRAYS IN THE LEO-PLASMA ENVIRONMENT: A MODEL FOR LEAKAGE CURRENT PHENOMENA DEDUCED FROM EXPERIMENTAL AND THEORETICAL STUDIES
H. Thiemann, Robert W. Schunk, and L. Gerlach (European Space Agency. European Space Research and Technology Center, ESTEC, Noordwijk, Netherlands) *In* ESA, European Space Power, Volume 2 Aug. 1989 p 809-813 (For primary document see N90-17748 10-20)
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N90-17803# Centre d'Etudes et de Recherches, Toulouse (France). Dept. d'Etudes et de Recherches Technologie Spatiale.
REVIEW OF SYNERGISTIC ENVIRONMENTAL INTERACTIONS: GUIDELINES FOR NEW TESTING APPROACHES ON FUTURE SOLAR ARRAYS
J. Berry, L. Levy, A. Paillous, K. Bogus, L. Gerlach, L. Pelenc, and N. Pchalek (Allgemeine Elektrizitaets-Gesellschaft, Wedel, Germany, F.R.) *In* ESA, European Space Power, Volume 2 Aug. 1989 p 815-821 (For primary document see N90-17748 10-20)
(Contract ESTEC-7438/87)
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N90-17808# Artegie (France).
WPK: SOLAR ARRAY DIMENSIONING TOOL
Ph. Bobo *In* ESA, European Space Power, Volume 2 Aug. 1989 p 851-854 (For primary document see N90-17748 10-20)
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45 ENVIRONMENT POLLUTION

Includes atmospheric, noise, thermal, and water pollution.

N90-18102*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
A FIELD STUDY OF SOLID ROCKET EXHAUST IMPACTS ON THE NEAR-FIELD ENVIRONMENT
B. J. Anderson and Vernon W. Keller Jan. 1990 87 p
(NASA-TM-4172; NAS 1.15:4172) Avail: NTIS HC A05/MF A01 CSCL 13B

Large solid rocket motors release large quantities of hydrogen chloride and aluminum oxide exhaust during launch and testing. Measurements and analysis of the interaction of this material with the deluge water spray and other environmental factors in the near field (within 1 km of the launch or test site) are summarized. Measurements of mixed solid and liquid deposition (typically 2 normal HCl) following space shuttle launches and 6.4 percent scale model tests are described. Hydrogen chloride gas concentrations measured in the hours after the launch of STS 41D and STS 51A are reported. Concentrations of 9 ppm, which are above the 5 ppm exposure limits for workers, were detected an hour after STS 51A. A simplified model which explains the primary features of the gas concentration profiles is included.
Author

N90-18103# Calspan Advanced Technology Center, Buffalo, NY.
CHAMBER INVESTIGATIONS OF THE FATE OF DIESEL EMISSIONS IN THE ATMOSPHERE, VOLUME 1, TASK 3 Final Report
T. M. Albrechcinski, B. J. Wattle, and J. G. Michalovic Jul. 1989 348 p Sponsored by Coordinating Research Council, Inc., Atlanta, GA
(Contract CAPA-13-76(1-84))
(PB90-114422; CALSPAN-7292-1-Vol-1;
CRC-APRAC-AP-2-1-Vol-1) Avail: NTIS HC A15/MF A02 CSCL 13B

This program quantified the effect of long term atmospheric exposure of diesel emissions to various types and concentrations of atmospheric pollutants under UV-irradiated and non-irradiated conditions. The influence of the mode of exhaust injection on the chemical and physical characteristics of the diesel exhaust/air mixture in the chamber, was examined. The effect of artifact formation and the effect of solvent efficiency on the mutagenic activity and chemical composition of organic extracts for a single experiment condition, were also examined. Experiments were designed to promote the formation of nitrated polycyclic aromatic hydrocarbon (PAH) derivatives and more polar compounds. The report consists of two volumes. Volume 1 is the final report which contains the detailed summary and discussion of work completed during the program.
GRA

N90-18104# Calspan Advanced Technology Center, Buffalo, NY.
CHAMBER INVESTIGATIONS OF THE FATE OF DIESEL EMISSIONS IN THE ATMOSPHERE. VOLUME 2: AMES ASSAY AND GCMS FINAL DATA REPORTS AND GAS PHASE PROJECTIONS Final Report
T. M. Albrechcinski, B. J. Wattle, and J. G. Michalovic Jul. 1989 235 p Sponsored by Coordinating Research Council, Inc., Atlanta, GA
(Contract CAPA-13-76(1-84))
(PB90-114430; CALSPAN-7292-1-Vol-2;
CRC-APRAC-AP-2-1A-Vol-2) Avail: NTIS HC A11/MF A02 CSCL 13B

This program quantified the effect of long term atmospheric exposure of diesel emissions to various types and concentrations of atmospheric pollutants under UV-irradiated and non-irradiated conditions. The influence of the mode of exhaust injection on the chemical and physical characteristics of the diesel exhaust/air mixture in the chamber was examined. The effect of artifact formation and the effect of solvent efficiency on the mutagenic activity and chemical composition of organic extracts for a single experiment condition, were also examined. Experiments were designed to promote the formation of nitrated polycyclic aromatic hydrocarbon (PAH) derivatives and more polar compounds. Volume 2 contains all documentation, including data reports of the mutagenicity and gas chromatography/mass spectroscopy (GCMS) analyses, and the preliminary projected gas phase concentrations for the chamber experiments.
GRA

N90-18105# Oak Ridge National Lab., TN. Environmental Science Div.
CONTINUOUS GAS EXCHANGE MEASUREMENTS USING INDIVIDUAL FASCICLE CUVETTES: THE TUBULE SYSTEM
P. J. Hanson and S. B. Mclaughlin 1989 6 p Presented at the Conference on Environmental Research With Plants in Closed Chambers, Munich (Federal Republic of Germany), 9-11 Oct. 1989
(Contract DE-AC05-84OR-21400)
(DE90-004932; CONF-8910337-1) Avail: NTIS HC A02/MF A01

A canopy level, gas exchange system that provides continuous measurements of CO2, H2O, and O3 exchange of tree canopies was developed and utilized under field conditions. The system is based on the open gas exchange principle. Each canopy sampling location consists of ten minicuvettes or tubules attached to tissues of the same age. Continuous, canopy gas exchange measurements of loblolly pine (Pinus taeda L.) needles were obtained periodically throughout the 1988 growing season under a range of growing conditions. These data were used to generate budgets of CO2 exchange, H2O exchange and O3 uptake over a range of time periods (e.g., hours, days, weeks). The continuous canopy level measurements are suitable for parameterizing multi-variable models, and for analyzing the relationship between incident light and CO2 exchange. The tubule system is a viable tool for assessing the physiological characteristics of canopy foliage.
DOE

N90-18106# Pacific Northwest Lab., Richland, WA.
EVAPOTRANSPIRATION STUDIES FOR PROTECTIVE BARRIERS: EXPERIMENTAL PLANS

S. O. Link and W. J. Waugh Nov. 1989 44 p
(Contract DE-AC06-76RL-01830)
(DE90-005206; PNL-6899) Avail: NTIS HC A03/MF A01

A general theory and experimental plans for predicting evapotranspiration in support of the Protective Barrier Program is described. Evapotranspiration is the combined loss of water from plants and soil surfaces to the atmosphere. DOE

N90-18107# Oak Ridge National Lab., TN. Energy Div.
ENERGY TECHNOLOGY R AND D AND THE GREENHOUSE EFFECT
P. D. Fairchild and W. Fulkerson 1990 11 p Presented at the 3rd International Energy Agency Heat Pump Conference, Tokyo, Japan, 12-15 Mar. 1990
(Contract DE-AC05-84OR-21400)
(DE90-001339; CONF-900334-2) Avail: NTIS HC A03/MF A01

Global warming from rising atmospheric CO2 concentrations is linked to fossil fuel use, which, in turn, is directly linked to energy end-use needs and what technologies we employ to meet those needs. None of the nonfossil options are ready yet to displace fossil fuels on the scale necessary to stop this rise. What do heat pumps have to do with the greenhouse warming effect. First, heat pumps represent one technology that can be used to increase the efficiency of energy use, which is the best near to mid-term strategy for reducing the rate of greenhouse warming. Also, chlorofluorocarbons (CFCs) used in heat pump, air conditioning, and refrigeration equipment have emerged as potential greenhouse gases. Future heat pump technology development therefore faces a complex set of trade-offs between direct atmospheric effects from CFC substitutes, indirect effects associated with energy efficiency and CO2 emissions, and providing options which can be used in the developing nations. Industrialized nations must recognize that solutions to these global environmental problems require international cooperation and worldwide participation. DOE

N90-18108# Los Alamos National Lab., NM.
A 3-D DYNAMICAL/CHEMICAL GCM FOR SIMULATING THE ANTHROPOGENICAL EFFECTS ON OZONE
C.-Y. Jim Kao, G. A. Glatzmaier, R. C. Malone, and R. P. Turco (California Univ., Los Angeles.) 1989 6 p Presented at the 14th Annual Climate Diagnostics Workshop, San Diego, CA, 16-20 Oct. 1989
(Contract W-7405-eng-36)
(DE90-004836; LA-UR-89-4077; CONF-8910338-1) Avail: NTIS HC A02/MF A01

In spite of the significantly increased attention atmospheric ozone has received over the last two decades or so, a fully quantitative understanding of the three-dimensional ozone structure remains unavailable. In the past, one-dimensional (vertical column) models have provided most of the quantitative simulations of atmospheric chemical systems, because these models can treat large ensembles of chemical process economically. More recently, two-dimensional (meridional cross section) models have become popular, in part because of increasing computer capabilities. There has been little work using a sophisticated 3-D General Circulation Model (GCM) coupled with a comprehensive photochemical model to study the chemical-dynamical interactions involving the ozone abundance. Namely, either the dynamics or the chemistry is too simplified in most of the existing models. Relatively more advanced photochemistry has been included in the stratospheric models (dealing the vertical domain from 20 to 70 km above the surface) at the expense of tropospheric details. An important motivation for this research has been the desire to estimate the magnitude of changes in the ozone layer induced by anthropogenic perturbations such as the injection of oxides of nitrogen and chlorine compounds. Accordingly, the attempt has been to develop a complete but feasible photochemical scheme and to combine it with the Los Alamos National Laboratory (LANL) 3-D GCM. DOE

N90-18109# Argonne National Lab., IL. Environmental Assessment and Information Sciences Div.
ENVIRONMENTAL IMPACT ASSESSMENT: PROCESS AND IMPLEMENTATION
S. Y. Chen and S. Y. Tsai 1989 12 p Presented at the Radwaste Symposium '89: Chinese Experts Radwaste Symposium, Taipei, Taiwan, 12-13 Dec. 1989
(Contract W-31-109-eng-38)
(DE90-004882; CONF-891270-2) Avail: NTIS HC A03/MF A01

In this paper, the procedures and issues regarding the preparation of an environmental impact assessment in accordance with the National Environmental Policy Act (NEPA) as promulgated by the U.S. Congress in 1969 are discussed. NEPA procedures and requirements are covered in general, while particular attention is given to the preparation of the environmental impact assessment. Also included is a discussion of the social impact assessment. The aim of the social impact assessment is to address the social issues involved in enhancing public understanding of the hazardous risks, thereby mitigating any conflicts that may arise in the NEPA process. DOE

N90-18110# Oak Ridge National Lab., TN. Environmental Sciences Div.
MODELING THE EFFECTS OF AIR POLLUTION ON FOREST ECOSYSTEMS: CONSIDERATIONS FOR APPLYING A MODEL TO SOUTHEAST ASIA
Virginia H. Dale 1989 44 p Presented at the Workshop to Design an Acid Deposition Policy Model for Southeast Asia, Bangkok, Thailand, 13-17 Nov. 1989
(Contract DE-AC05-84OR-21400)
(DE90-004937; CONF-8911158-1) Avail: NTIS HC A03/MF A01

This paper concentrates on assessing the effects of acid rain on terrestrial ecosystems. However, terrestrial effects are determined by the location and intensity of the source pollutant and by the repercussions of damage of terrestrial resources on the social and economic systems. Therefore, the fully integrated assessment must consider multiple aspects of the industrial, biotic, social, and economic systems. This paper describes a model of forest development that has been used to assess disturbance impacts in North America, Europe, and Australia. Pertinent applications of the model are discussed. The model has been used to project the regional effects of growth declines such as may result from air pollution. The model has also been used to test hypotheses for explanations for the observed tree decline that may be independent of air pollution. The model has been used to show that past disturbances must also be considered in assessing air pollution effects to forests. Finally, the paper discusses how the model structure can be applied to forests of Southeast Asia. DOE

N90-18111# Illinois State Water Survey, Champaign.
ASSESSMENT OF THE THEORY AND HYPOTHESES OF THE ACIDIFICATION OF WATERSHEDS
Edward C. Krug Apr. 1989 264 p
(Contract DE-FG02-87ER-30126)
(DE90-005528; DOE/ER-30126/1) Avail: NTIS HC A12/MF A02

This report documents and critically assesses the evolution and status of the scientific understanding of the effects of acidic deposition on surface waters. The main conclusion is that the dominant theory of surface-water acidification fails to adequately incorporate many important factors and processes that influence surface water acidity. Some of these factors and processes are not well researched or recognized as being important by most scientists in the aquatic effects research area. DOE

46 GEOPHYSICS

Includes aeronomy; upper and lower atmosphere studies; ionospheric and magnetospheric physics; and geomagnetism.

For space radiation see *93 Space Radiation.*

N90-18112# International Centre for Theoretical Physics, Trieste (Italy).
SELF-SIMILAR GROWTH OF THREE-DIMENSIONAL FAULT
Huilan Zhou Apr. 1989 13 p Submitted for publication
(DE90-608162; IC-89/51) Avail: NTIS (US Sales Only) HC A03/MF A01

By using forthright mathematical treatment, this paper expands the two-dimensional Self-Similar model of faulting proposed by Fukao and Furumoto (1985) in three-dimensions, and explains the energy ratio of alpha of precursor to main shock, magnitude difference delta mu between the main shock and its largest aftershock, and b value in magnitude-frequency relationship. The present model gives alpha 0.08, delta mu = 1.21 and b = 1.5, respectively. These results are more consistent with the observations than the two-dimensional model. DOE

N90-18113# Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).
SIMULTANEOUS OBSERVATIONS OF THE EMISSIONS OI (5577), O2A(0.1), NaD(5893) AND OH(9.4) AND THE ROTATIONAL TEMPERATURES TO2 AND TOH IN THE UPPER ATMOSPHERE M. S. Thesis - Sep. 1988
Paulo Roberto Fagundes Jul. 1989 121 p In PORTUGUESE; ENGLISH summary
(INPE-4851-TDL/366) Avail: NTIS HC A06/MF A01

Simultaneous measurements of the OI 5577 A, NaD O2A (0.1) and OH (9.4) nightglow emissions from the mesopause region were carried out at Cachoeira Paulista (22.7 S, 45.0 W) since 1983. Both the O2 and OH measurements are used to study rotational temperature, TO2 and TOH, respectively. All these emissions involve atomic oxygen and originate a narrow region of about 15 to 20 km width centered on 90 km. Therefore observations of temporal intensity and rotational temperature variations provide an important remote sensing technique to study the mesospheric photochemistry and dynamics. A cross-correlation analysis between intensity variations of different emissions and rotational temperature for the measurements obtained during the period January 1987 to January 1988 was carried out. It was observed that the rotational temperature responds much more rapidly as compared to intensity variation when a wovelike perturbation occurred in the mesopause region. Author

N90-18114*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
PROCESSING OF DMSP MAGNETIC DATA: HANDBOOK OF PROGRAMS, TAPES, AND DATASETS
R. A. Langel, T. J. Sabaka, and J. R. Ridgway (Science Applications Research, Lanham, MD.) Feb. 1990 176 p
(NASA-TM-100757; Rept-90-076; NAS 1.15:100757) Avail: NTIS HC A09/MF A01 CSCL 08G

The DMSP F-7 satellite was an operational Air Force meteorological satellite which carried a magnetometer for geophysical measurements. The magnetometer was located within the body of the spacecraft in the presence of large spacecraft fields. In addition to stray magnetic fields, the data have inherent position and time inaccuracies. Algorithms were developed to identify and remove time varying magnetic field noise from the data. These algorithms are embodied in an automated procedure which fits a smooth curve through the data and then identifies outliers and which filters the predominant Fourier component of noise from the data. Techniques developed for Magsat were then modified and used to attempt determination of the spacecraft fields, of any rotation between the magnetometer axes and the spacecraft axes, and of any scale changes within the magnetometer itself. Software setup and usage are documented and program listings are included in the Appendix. The initial and resulting data are archived on magnetic cartridge and the formats are documented. Author

N90-18115# Massachusetts Inst. of Tech., Lexington. Lincoln Lab.
PRELIMINARY EXPERIMENTAL MEASUREMENT OF ISOPLANATIC ANGLE
D. Marquis and K. A. Winick 11 Oct. 1989 24 p
(Contract F19628-85-C-0002)
(AD-A215828; TR-858; ESD-TR-89-165) Avail: NTIS HC A03/MF A01 CSCL 04/2

Group 67 has designed and built an isoplanometer, an instrument which remotely measures the isoplanatic angle associated with atmospheric turbulence conditions. The isoplanatic angle is loosely defined as the angular field over which the spatial transfer function of the atmosphere can be assumed to be invariant. Verification of the instrument required nighttime testing using stellar sources to measure current atmospheric conditions. Preliminary results from a verification experiment and a brief description of the instrument are presented. Full instrument verification requires locating the instrument at a better astronomical site; therefore, the data should not be considered a valid characterization of the atmospheric conditions in Lexington, Mass. GRA

N90-18332*# Michigan Univ., Ann Arbor.
REPORT FROM UPPER ATMOSPHERIC SCIENCE
G. R. Carignan, R. G. Roble, S. B. Mende (Lockheed Missiles and Space Co., Palo Alto, CA.), A. F. Nagy, and R. D. Hudson *In* NASA, Marshall Space Flight Center, Solar-Terrestrial Science Strategy Workshop Sep. 1989 p 9-13 (For primary document see N90-18329 10-88)
Avail: NTIS HC A04/MF A01; 4 functional color pages CSCL 04A

N90-18333*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
REPORT FROM IONOSPHERIC SCIENCE
W. J. Raitt, Peter M. Banks, A. F. Nagy (Michigan Univ., Ann Arbor.), and C. R. Chappell *In its* Solar-Terrestrial Science Strategy Workshop Sep. 1989 p 15-23 (For primary document see N90-18329 10-88)
Avail: NTIS HC A04/MF A01; 4 functional color pages CSCL 04A

N90-18334*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
REPORT FROM MAGNETOSPHERIC SCIENCE
J. L. Burch, J. D. Winningham, H. R. Anderson, D. N. Baker, C. R. Chappell, and W. W. L. Taylor (TRW Defense and Space Systems Group, Redondo Beach, CA.) *In its* Solar-Terrestrial Science Strategy Workshop Sep. 1989 p 25-30 Original contains color illustrations (For primary document see N90-18329 10-88)
Avail: NTIS HC A04/MF A01; 4 functional color pages CSCL 04A

N90-18337*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
MAJOR THEMES IN THE FUTURE OF SOLAR-TERRESTRIAL SCIENCE
In its Solar-Terrestrial Science Strategy Workshop Sep. 1989 p 61-64 (For primary document see N90-18329 10-88)
Avail: NTIS HC A04/MF A01; 4 functional color pages CSCL 04A

47 METEOROLOGY AND CLIMATOLOGY

Includes weather forecasting and modification.

N90-18116# Army Cold Regions Research and Engineering Lab., Hanover, NH. Geophysical Sciences Branch.
OPTICAL MEASUREMENT OF PRECIPITATION
Gary Koh Sep. 1989 17 p

(DA Proj. 4A1-61102-AT-24)
(AD-A214357; CRREL-SR-89-30) Avail: NTIS HC A03/MF A01 CSCL 04/2

A simple optical device is used to measure changes in light intensity caused by precipitating particles as they fall through a beam of light. The intensity changes are analyzed in the amplitude and frequency domains to obtain information about precipitation. Tests conducted in snow and in rain show that the optical device can be used for characterizing precipitation with finer time resolution than conventional methods. Rain rates can be accurately monitored; however, errors in snow rates can be as high as a factor of two. Number flux measurements suggest that periodic trends may exist during snow and rain. Power spectra of the intensity changes show that spectral signatures exist for different types of precipitation. GRA

N90-18117# Air Force Environmental Technical Applications Center, Scott AFB, IL.
SURFACE OBSERVATION CLIMATIC SUMMARIES (SOCS) FOR PEASE AIR FORCE BASE, NEW HAMPSHIRE Data Summary Report, Apr. 1956 - Jun. 1989
Sep. 1989 753 p LIMITED REPRODUCIBILITY: Availability: Document partially illegible
(AD-A215750; USAFETAC/DS-89/219) Avail: NTIS HC A99/MF A04 CSCL 04/2

Surface Observation Climatic Summaries (SOCS) provide statistical climatic summaries of surface weather observations taken and recorded at specified USAF, civilian, and foreign observing stations. Hourly observations are summarized from a 10-year period of record (POR). Summary of Day (SOD) information is summarized from all available data in the OL-A climatic database. GRA

N90-18118# Lawrence Livermore National Lab., CA.
DOSE ASSESSMENT DURING COMPLEX METEOROLOGY IN THE TEXAS PANHANDLE
Walter W. Schalk, III and Kevin Foster Jun. 1989 7 p Presented at the Winter Meeting of the American Nuclear Society, San Francisco, CA, 26-30 Nov. 1989 Submitted for publication
(Contract W-7405-eng-48)
(DE90-006026; UCRL-101216; CONF-891103-65) Avail: NTIS HC A02/MF A01

Recently the opportunity arose to perform a radiological assessment during complex meteorological conditions in the panhandle region of Texas. The complex conditions consisted of the formation of an occluded front from a trof and its passage from the southwest, a southwest to northeast trof formation northwest of the assessment point, an area of low pressure centered to the west, and severe thunderstorms at the assessment time at and near the study region while under watch box notification. Most of these features can be seen on the 17 May 89 surface analysis. The assessment included a normalized release rate of tritiated water vapor in which the 50 year committed effective whole body integrated air dose plots were compared over time. DOE

N90-18119# Central Research Inst. of Electric Power Industry, Tokyo (Japan). Energy and Environment Lab.
CONTINUING CURRENT IN CLOUD-TO-GROUND LIGHTNING
Takatoshi Shindo May 1989 33 p In JAPANESE; ENGLISH summary
(DE90-741969; CRIE-T-88097) Avail: NTIS (US Sales Only) HC A03/MF A01

Electric fields of natural lightening strokes in summer were measured and statistical natures of continuing current were analyzed to clarify lightning characteristics. Statistical analysis between peak values of electric field intensity accompanied with lightning duration, return stroke on the basis of electric field wave change at lightning and continuing current; was carried out to get following knowledges: Observed lightning number was 90. When continuing current occurs, the duration was longer than usual lightning by 2 to 4 times and preceding interstroke duration is half of usual one. The peak value of electric field intensity accompanied by return stroke just before continuing current, was measured by a fast antenna having rapid frequency response and the value was about 70 percent of peak value of electric field intensity accompanied by usual return stroke. This means that current by dart leader just before continuing current is smaller than that by usual dart leader on the average. DOE

N90-18120*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
AN ATLAS OF ECMWF ANALYSES (1980-87). PART 1: FIRST MOMENT QUANTITIES
S. Schubert, C.-K. Park, W. Higgins, S. Moorthi (Universities Space Research Association, Columbia, MD.), and M. Suarez Jan. 1990 236 p
(Contract NAS5-30506)
(NASA-TM-100747-Pt-1; Rept-89B00254; NAS 1.15:100747-Pt-1) Avail: NTIS HC A11/MF A02 CSCL 04B

This document is an atlas of the European Center for Medium Range Weather Forecasts (ECMWF) initialized analyses for 1980 to 1987. Various first moment quantities are presented for monthly, seasonal, and annual averages on a global cylindrical projection, as well as, cross section maps of zonal averages. Global maps of winds, temperature, stream function, and velocity potential are presented at 850 and 200 mb. In addition, global maps of the 300 mb height field (total and eddy), the 500 mb vertical velocity, the 850 mb moisture field, and sea level pressure are presented. The average seasonal cycle and anomalies during the 8 year period are presented for selected quantities. Author

N90-18121# Naval Postgraduate School, Monterey, CA.
AN ANALYSIS OF DIURNAL WIND VARIABILITY IN THE SANTA BARBARA CHANNEL FROM SODAR MEASUREMENTS M.S. Thesis
Douglas H. Scovil, Jr. Jun. 1989 85 p
(AD-A215769) Avail: NTIS HC A05/MF A01 CSCL 04/2

Diurnal wind variability within the atmospheric boundary layer along the coast of the Santa Barbara Channel is studied by spectral analysis of SODAR (Sound Detection and Ranging) wind measurements. Rotary spectral analysis is used to investigate wind circulations and oscillations in the vertical. Power density spectral analysis is used to find frequencies with the greatest amount of kinetic energy. The results show a tendency for counterclockwise rotation in the lowest level and clockwise rotation in the upper levels. Some cases show counterclockwise rotation in all levels. Most of the kinetic energy was concentrated at a diurnal frequency related to local sea and land breezes. However, a secondary kinetic energy maximum is consistently found at a sub-diurnal frequency. The source of this sub-diurnal energy in the vertical may be a mesoscale circulation, such as the Gaviota Eddy or the Catalina Eddy. GRA

N90-18122# Air Force Environmental Technical Applications Center, Scott AFB, IL.
SURFACE OBSERVATION CLIMATIC SUMMARIES
Sep. 1989 697 p
(AD-A215786; USAFETAC/DS-89/220) Avail: NTIS HC A99/MF A04 CSCL 04/2

Surface observation climatic summaries (SOCS) provide statistical climatic summaries of surface weather observations taken and recorded at specified USAF, civilian, and foreign observing stations. Hourly observations are summarized from a 10-year period of record (POR). Summary of Day (SOD) information is summarized from all available data in the OL-A climatic database. GRA

N90-18123# Aeronautical Research Labs., Melbourne (Australia).
REPORT ON METEOROLOGICAL ASSESSMENT OF BALD HILLS INCIDENTS, PHASE 1
R. K. Smith, S. Haase, and E. Smith (Monash Univ., Melbourne, Australia) Jul. 1989 26 p
(AD-A216201; ARL-STRUC-TM-518; DODA-AR-005-627) Avail: NTIS HC A03/MF A01 CSCL 04/2

A number of wind shear events recorded at the Bald Hills tower in Brisbane Australia has been examined and grouped

according to cause. The cases include thunderstorms, sea breezes, late night (probably inversion related) incidents, and wave motions. GRA

N90-18124# Lowell Univ., MA. Dept. of Earth Sciences.
SUPER-MICRO COMPUTER WEATHER PREDICTION MODEL
Keith L. Seitter and Frank P. Colby, Jr. Aug. 1989 41 p
(Contract F19628-88-K-0016)
(AD-A216329; GL-TR-89-0239) Avail: NTIS HC A03/MF A01 CSCL 04/2

A meso-beta scale model is being developed to provide forecast guidance in the 3 to 18 hour time period. The model is intended for use at local base weather offices equipped with a super-micro class computer, allowing these offices to produce local forecast guidance for their region. The model consists of a four-layer sigma-coordinate model which has a two-layer boundary layer model nested within its lower layer. The vertically nested two-layer model allows direct calculation of boundary layer quantities through simple parameterizations for radiative processes and surface fluxes. The model has a 480 x 480 km horizontal domain with 20 km resolution which is nested horizontally, using a two-way interactive procedure, within a 1320 x 1320 km coarse grid domain with 60 km resolution. This report presents the equation sets for the nested model and the physical parameterizations. It also summarizes tests of the nested four-layer/two-layer model structure which have been completed, and separate tests of the parameterization package. GRA

N90-18125*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
THE 1985 AND 1986 DIRECT STRIKE LIGHTNING DATA, PART 1
Klaus P. Zaepfel and Harold K. Carney Mar. 1988 500 p
(NASA-TM-100533-Pt-1; NAS 1.15:100533-Pt-1) Avail: NTIS HC A21/MF A03 CSCL 04B

Data waveforms are presented which were obtained during the 1985 and 1986 direct-strike lightning tests utilizing the NASA F-106B aircraft specially instrumented for lightning electromagnetic measurement. The aircraft was operated in the vicinity of the NASA Langley Research Center, Hampton, Virginia, in a thunderstorm environment in order to elicit lightning strikes. Electromagnetic field data and conduction currents on the aircraft were recorded for lightning. Author

N90-18126*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
THE 1985 AND 1986 DIRECT STRIKE LIGHTNING DATA, PART 2
Klaus P. Zaepfel and Harold K. Carney Mar. 1988 472 p
(NASA-TM-100533-Pt-2; NAS 1.15:100533-Pt-2) Avail: NTIS HC A20/MF A03 CSCL 04B

Data waveforms are presented which were obtained during the 1985 and 1986 direct-strike lightning tests utilizing the NASA F-106B aircraft specially instrumented for lightning electromagnetic measurements. The aircraft was flown in the vicinity of the NASA Langley Research Center, Hampton, Virginia, in a thunderstorm environment in order to elicit lightning strikes. Electromagnetic field data and conduction currents on the aircraft were recoded for lightning. Author

48 OCEANOGRAPHY

Includes biological, dynamic, and physical oceanography; and marine resources.

For related information see also *43 Earth Resources and Remote Sensing.*

N90-18127*# Colorado State Univ., Fort Collins. Dept. of Atmospheric Science.
ON THE RELATIONSHIP BETWEEN WATER VAPOR OVER THE OCEANS AND SEA SURFACE TEMPERATURE
Graeme L. Stephens Nov. 1989 38 p Revised
(Grant NAG5-1122)
(NASA-CR-186199; NAS 1.26:186199) Avail: NTIS HC A03/MF A01 CSCL 08C

Monthly mean precipitable water data obtained from passive microwave radiometry were correlated with the National Meteorological Center (NMC) blended sea surface temperature data. It is shown that the monthly mean water vapor content of the atmosphere above the oceans can generally be prescribed from the sea surface temperature with a standard deviation of 0.36 g/sq cm. The form of the relationship between precipitable water and sea surface temperature in the range T(sub s) greater than 18 C also resembles that predicted from simple arguments based on the Clausius-Clapeyron relationship. The annual cycle of the globally integrated mass of Scanning Multichannel Microwave Radiometer (SMMR) water vapor is shown to differ from analyses of other water vapor data in both phase and amplitude and these differences point to a significant influence of the continents on water vapor. Regional scale analyses of water vapor demonstrate that monthly averaged water vapor data, when contrasted with the bulk sea surface temperature relationship developed in this study, reflect various known characteristics of the time mean large-scale circulation over the oceans. A water vapor parameter is introduced to highlight the effects of large-scale motion on atmospheric water vapor. Based on the magnitude of this parameter, it is shown that the effects of large-scale flow on precipitable water vapor are regionally dependent, but for the most part, the influence of circulation is generally less than about + or - 20 percent of the seasonal mean. Author

N90-18128# Colorado Univ., Boulder.
THE EFFECTS OF ABRUPT TOPOGRAPHY ON OCEAN CURRENTS AS SENSED BY SATELLITE REMOTE SENSING Annual Report, 1 Oct. 1988 - 30 Sep. 1989
William J. Emery 25 Oct. 1989 27 p
(AD-A214123) Avail: NTIS HC A03/MF A01 CSCL 08/3

The objective is to use a variety of remote sensing methods to study the interaction between ocean circulation and the abrupt bottom topography at the location of Fieberling seamount in the eastern Pacific Ocean (west of Los Angeles). In support of these satellite measurements the project includes the collection of shipborne XBT surveys of the area around the Fierberling seamount. The satellite data tools being studied are the Advanced Very High Resolution Radiometer (AVHRR) on the NOAA TIROS-N weather satellites and the RADAR altimeter on the GEOSAT satellite. The AVHRR data can be processed to produce 1 km resolution images of sea surface temperature (SST) from the infrared AVHRR channels. Sequential SST images can be used to estimate ocean surface currents from advection of the surface temperature patterns. The GEOSAT altimetry can be used to monitor the temporal changes of the sea surface elevation which can then be converted to estimates of the changes in geostrophic currents. Thus the 2 years of GEOSAT data available supply a valuable picture of the changes in the geostrophic currents in the area around Fieberling. GRA

N90-18129# Colorado Univ., Boulder.
EFFECTS OF HEATING/COOLING ON CHANGES IN SEA SURFACE TEMPERATURE: CONSEQUENCES FOR COMPUTATION OF SURFACE ADVECTION FROM SATELLITE IMAGES Annual Report
William J. Emery 24 Oct. 1989 29 p
(AD-A214125) Avail: NTIS HC A03/MF A01 CSCL 08/3

Error sources in computing surface advection from sequential satellite images were studied, primarily focusing on interpretation of infrared weather satellite-derived sea surface temperature (SST) images. To evaluate effects of heating and cooling at the ocean's surface, the FASINEX data set was acquired along with coincident AVHRR images of the same region. A simple study of the satellite temperatures and those measured at the FASINEX moorings suggests the advective nature of the surface temperature field. A more detailed model is being developed to reveal detailed relationships between surface heat fluxes and the change of SST seen in the satellite images. AVHRR and CZCS imagery are being

studied simultaneously to understand the similarities and differences between surface motion computed from changes in SST patterns and motion computed from changes in ocean color as revealed by the CZCS instrument. Unfortunately, the CZCS imagery available was with 24 hour separations between images while the AVHRR can have separations as short as 4 to 6 hours. The shorter the interval the better the performance of the surface velocities computed from AVHRR data. While there are similarities between the AVHRR and CZCS data patterns there are also some marked differences between the two types of imagery. The question is are these differences caused by the very different competing sources of local variation (i.e., heat flux for SST and biological activity for CZCS) or by advection changes of the surface patterns being tracked. GRA

N90-18130# Scripps Institution of Oceanography, La Jolla, CA. Marine Physical Lab.
OBSERVATIONS OF FINE-SCALE VERTICAL SHEAR AND STRAIN IN THE UPPER OCEAN Ph.D. Thesis
Jeffrey Thomas Sherman Jun. 1989 128 p
(Contracts N00014-79-C-0472; N00014-87-K-0010)
(AD-A214476; MPL-U-49/89; SIO-REF-89-11) Avail: NTIS HC A07/MF A01 CSCL 08/3

This thesis addresses the vertical wavenumber frequency (m, omega) distribution of vertical shear and strain in the upper ocean. Part of the data set includes measurements from a newly-developed pulse-to-pulse coherent sonar. Chap. 2 discusses its design and performance. Chap. 3 investigates the effects of zooplankton distribution on Doppler sonars which use small ensonified volumes. A secondary data set of isopycnal vertical displacement (eta) was collected with a profiling CTD system. Vertical shear (del w/del z, del v/del z) and vertical strain (del m/del z) data are analyzed in Chap. 4. GRA

N90-18131# Miami Univ., Coral Gables, FL. Dept. of Physics.
SOME PROBLEMS IN OCEANIC RADIATIVE TRANSFER Final Report
Howard R. Gordon May 1989 112 p
(Contract N00014-84-K-0451)
(AD-A215935) Avail: NTIS HC A06/MF A01 CSCL 08/1

The research describes the distribution of phyto-plankton in the world's oceans through their influence on the optical properties of the water. Optically, phytoplankton reveal their presence through the absorption of light by their photosynthetic (chlorophyll a) and accessory pigments. This is usually indirectly inferred by virtue of its effect on the apparent optical properties: the diffuse reflectance of the water, e.g., the color of the water, or the downwelling irradiance attenuation coefficient. The construction of mathematical models which simulate a closely as possible the physical processes can make a very valuable contribution because the various parameters are known and carefully controlled in the models. Two specific interrelated goals for the present research are: (1) to understand the influence of the optical properties of the ocean as determined by the concentration of phytoplankton, detrital particles, dissolved organic material, etc., on the transport of light from a point source in the ocean to the sea surface, for possible application to the remote (surface) detection of bioluminescence; and (2) to understand the dependence of the classical apparent optical properties (the irradiance attenuation coefficient and the diffuse reflectance) on the inherent optical properties (absorption and scattering coefficient and the volume scattering function). GRA

N90-18132# Lamont-Doherty Geological Inst., Palisades, NY.
SEGMENTATION OF TOPOGRAPHIC PROFILES OF THE SEAFLOOR BASED ON A SELF-AFFINE MODEL
Alberto Malinverno Oct. 1989 15 p
(Contract N00014-87-K-0204)
(AD-A215938; LDGO-CONTRIB-4498) Avail: NTIS HC A03/MF A01 CSCL 08/3

Profiles of seafloor topography can be statistically described as a self-affine stochastic time series characterized by only a few parameters. In this paper, two characteristic parameters will be used: A correlation parameter (the spectral exponent beta, which is related to the fractal dimension D), and an amplitude parameter (an index of dispersion of the first differences S). This characterization provides a simple quantification of the intuitive notion of the roughness of topography. The quantification of roughness is important to effectively classify areas of the seafloor where topography is dominated by different processes (e.g., sedimentation, volcanism, faulting). However, unless the data are subdivided into portions that are statistically stationary (i.e., have statistical parameters that are invariant in space), the results of such characterization are not meaningful. The procedure used in this paper can be subdivided into three steps: (1) The profiles are subdivided into statistically homogeneous segments; (2) statistical parameters are measured on each segment; and (3) the segments are grouped into classes with similar statistical parameters. Steps one and two are completely automatic. The method was applied to segment and classify topographic profiles of the seafloor in the vicinity of the axis of the Explorer ridge, NE Pacific Ocean. GRA

51 LIFE SCIENCES (GENERAL)

N90-18133# Central Research Inst. of Electric Power Industry, Chiba (Japan).
BREEDING OF HYDROGEN PRODUCING ANAEROBIC BACTERIA. CELLULASE SECRETION FROM TRANSFORMED ESCHERICHIA COLI JM109
Seigo Shima Jan. 1989 16 p In JAPANESE; ENGLISH summary
(DE90-710739; CRIE-U-88055) Avail: NTIS (US Sales Only) HC A03/MF A01

One of the applications of biotechnology to the electric power industry is production of hydrogen for fuel cells by microorganisms. This study is to conduct breeding of the microorganism which decomposes cellulose, the main component of plant, and produces hydrogen efficiently by using the gene manipulation methods. When cellulose decomposing enzyme genes were introduced into Escherichia coli JM109 whose cell membrane structure varied partially and the places where the cellulose decomposing enzyme existed inside as well as outside its body were checked, it was found that the majority of the cellulose decomposing enzymes were discharged towards the outside of the body beyond the surface space of the cell. This phenomenon is the academically important information, but from the practical standpoint, the ability of discharging into the cell surface space using such Escherichia coli without variations as Escherichia coli HB101 is required, hence it is desired to obtain the gene which has the discharging ability as stated above and produces cellulose decomposing enzymes with strong decomposing power. DOE

N90-18134# Naval Medical Research Inst., Bethesda, MD.
ARGININE VASOPRESSIN LOWERS PULMONARY ARTERY PRESSURE IN HYPOXIC RATS BY RELEASING ARTRIAL NATRIURETIC PEPTIDE
Hongkui Jin, Yiu-Fai Chen, Ren-Hui Yang, Thomas M. McKenna, Robert M. Jackson, and Suzanne Opari 6 Dec. 1988 42 p
Sponsored by Department of the Navy, Washington, DC; National Dairy Board; and National Dairy Council
(Grants HL-35051; HL-22544)
(AD-A215986; NMRI-88-94) Avail: NTIS HC A03/MF A01 CSCL 06/15

We previously demonstrated that arginine vasopressin (AVP) lowers pulmonary artery pressure in rats with hypoxic pulmonary hypertension by activation of the V1 receptor. The pulmonary depressor effect of AVP in hypoxia adapted rats is not due to its effect on cardiac output. The current study tested two alternative hypotheses: that AVP lowers pulmonary artery pressure in the hypoxia adapted lung by: (1) dilating pulmonary vasculature directly, or (2) releasing atrial natriuretic peptide (ANP) from the heart. The first hypothesis was tested by injecting AVP into the pulmonary arteries of isolated, buffer perfused lungs and monitoring pulmonary artery pressure, and by exposing preconstricted pulmonary artery

rings to graded doses of AVP and monitoring the tension generated. AVP caused minimal vasodilation in prefused lungs and only a small vasodilator effect in pulmonary artery rings. The second hypothesis was tested by injecting AVP (160 ng/kg) or vehicle intravenously in conscious hypoxia adapted (4 weeks) or air control rats and measuring ANP in arterial blood and atria, and by testing pretreatment with the V1 receptor antagonist d(CH2)5 Tyr (Me) AVP (130 micrograms/kg) on the AVP-induced increase in plasma ANP. AVP produced a 7-fold increase in plasma ANP in hypoxia adapted rats and a 5-fold increase in ANP in air controls. ANP release was abolished by pretreatment of both groups with d(CH2)5 Tyr(Me)AVP. GRA

52 AEROSPACE MEDICINE

Includes physiological factors; biological effects of radiation; and effects of weightlessness on man and animals.

N90-18135# Human Engineering Labs., Aberdeen Proving Ground, MD.
EFFECT OF CONTRALATERAL MASKING PARAMETERS ON DIFFERENCE LIMEN FOR INTENSITY Final Report
Leslie J. Peters Sep. 1989 81 p
(DA Proj. 1L6-1102-B7-4A)
(AD-A214169; HEL-TM-11-89) Avail: NTIS HC A05/MF A01 CSCL 23/2

The effect of narrow band and wide band contralateral masking using different overall sound pressure levels (SPL) on a difference limen (threshold) for intensity task was investigated. Specifically, the narrow band of masking was created by passing white noise through a 1/10 octave filter. The wide band of masking was created by passing this noise through a 1/3 octave filter. The results indicated that: contralateral masking influenced a subject's ability to detect small changes in intensity. These masking effects did not change significantly (p is less than 0.5) from day 1 to day 2 of the experiment. When the overall SPL was changed by 6 dB and the bandwidth held constant at either 277 or 926 Hz, no significant difference was discovered in the ability to detect small incremental intensity changes. When the masking bandwidth were varied and the overall SPL was held constant, a significant difference occurred. The wide band masking conditions were all more sensitive than the narrow bandwidths with the same SPL. When the bandwidth and the overall SPL of the contralateral masker were varied, a significant difference occurred. The experiment demonstrated that the wide band masker appeared to widen the ipsilateral critical band at 4000 Hz and that this pattern held for the four levels (30, 36, 50, 56 dB) of wide band masking presented. GRA

N90-18136* National Aeronautics and Space Administration, Washington, DC.
AEROSPACE MEDICINE AND BIOLOGY: A CONTINUING BIBLIOGRAPHY WITH INDEXES (SUPPLEMENT 333)
Feb. 1990 53 p
(NASA-SP-7011(333); NAS 1.21:7011(333)) Avail: NTIS HC A04; NTIS standing order as PB89-912300, $10.50 domestic, $21.00 foreign CSCL 06E

This bibliography lists 122 reports, articles and other documents introduced into the NASA Scientific and Technical Information System during January, 1990. Subject coverage includes: aerospace medicine and psychology, life support systems and controlled environments, safety equipment, exobiology and extraterrestrial life, and flight crew behavior and performance. Author

N90-18137* National Aeronautics and Space Administration, Washington, DC.
AEROSPACE MEDICINE AND BIOLOGY: A CONTINUING BIBLIOGRAPHY WITH INDEXES (SUPPLEMENT 331)
Jan. 1990 55 p
(NASA-SP-7011(331); NAS 1.21:7011(331)) Avail: NTIS HC A04; NTIS standing order as PB89-912300, $10.50 domestic, $21.00 foreign CSCL 06E

This bibliography lists 129 reports, articles and other documents introduced into the NASA Scientific and Technical Information System during December, 1989. Subject coverage includes: aerospace medicine and psychology, life support systems and controlled environments, safety equipment, exobiology and extraterrestrial life, and flight crew behavior and performance. Author

N90-18138# Dayton Univ., OH.
SAFETY EVALUATION OF INFRARED LAMP POWER OUTPUT FOR OCULOMETER EYE/HEAD TRACKER SYSTEM Final Report, Sep. 1988 - Sep. 1989
R. J. Evans and J. C. Gainer (Air Force Human Resources Lab., Williams AFB, AZ.) Dec. 1989 33 p
(Contract F33615-87-C-0012)
(AD-A215809; AFHRL-TP-89-63) Avail: NTIS HC A03/MF A01 CSCL 17/5

The Air Force is concerned about the possible long-term effects of radiation used to illuminate the eye for eye tracking purposes. Toward this purpose, measurements were taken to determine the power output of the halogen lamp from the oculometer of the Honeywell (Type YG1784AO1) head and eye tracker used at the Air Force Human Resources Laboratory, Operations Training Division (AFHRL/OT), Williams AFB, Arizona. Radiation from the lamp (General Electric Lamp No. 784, Emergency Lighting - Halogen) is projected through the optics of the helmet onto the user's eye. The returned or reflected signal from the pupillary region of the eye is subsequently analyzed to determine eye position. A thermopile was placed behind a small aperture at the eye position inside the helmet in order to measure the amount of radiation at the eyepoint. Output of the halogen lamp varied with input current where minimum and maximum operational currents were .8 and 1 ampere. Irradiance measurements recorded using the thermopile were .20 milliwatts/sq cm for an .8-amp input and .55 mW/sq cm for a 1-amp input. These reading were determined to be well within safety standards currently set by industry. However, it is suggested that ocular exposure to such radiation be minimized, as more research is required in order to ascertain chronic effects resulting from long-term exposure of the eye to low levels of radiation. GRA

N90-18139# California Univ., Irvine. Center for the Neurobiology of Learning and Memory.
ACETYLCHOLINESTERASE INHIBITION AND INFORMATION PROCESSING IN THE AUDITORY CORTEX Final Report, 1 Apr. 1985 - 31 Dec. 1988
Norman M. Weinberger 17 Aug. 1989 52 p
(Contract DAMD17-85-C-5072; DA Proj. 3M1-61102-BS-11)
(AD-A216092) Avail: NTIS HC A04/MF A01 CSCL 06/15

The goal of this project is to determine the effects of anticholinesterases on the processing of information in the auditory cortex. Cholinergic agonists, blockers and anticholinesterases were applied to the auditory cortex of the cat via multibarrel micropipettes, while the discharges of single neurons to calibrated acoustic stimuli were recorded. Muscarinic agonists modified neuronal responses to sound in highly specific ways rather than producing a global change in response. Muscarinic agonists modified frequency-receptive fields, including shifts in the receptive field to new best frequencies and both increases and decreases in frequency selectivity. Agonist effects were dose-dependent and could be blocked by atropine. Application of the anticholinesterases eserine and soman produced the same type of effects except that the effects of soman are considerably exaggerated and permanent within the recording period possible for single neurons. This action profoundly disturbs the encoding and representation of information. Proposed means for central nervous system protection or therapy against anticholinesterases should be assayed by the highly sensitive receptive field analysis used here. Finally, we formulated a cholinergic model of cortical information processing which explains how endogenous acetylcholine (ACh) is essential

for normal cortical information processing and memory, forming a foundation for understanding anticholinesterase disruption of processing. GRA

N90-18140# Naval Medical Research Inst., Bethesda, MD.
USE OF SELF-INDUCED HYPNOSIS TO MODIFY THERMAL BALANCE DURING COLD WATER IMMERSION Final Report, Oct. 1988 - Apr. 1989
K. D. Mittleman, T. J. Doubt, and M. Gravitz Oct. 1989 34 p Sponsored by Naval Medical Research and Development Command, Bethesda, MD
(AD-A216156; NMRI-89-59) Avail: NTIS HC A03/MF A01 CSCL 06/10

This study was designed to evaluate the efficacy of self-induced post-hypnotic suggestion to improve physical and thermogenic responses to two cycles of alternating rest and exercise during head-out immersion in 25 C water. Twelve U.S. Navy divers volunteered to participate in two immersions conducted at the same time of day but spaced one week apart. The first immersion (control) was conducted prior to hypnotic training sessions on mental imagery and post-hypnotic suggestion techniques. There were no differences in rates of heat production, heat loss or net thermal balance between control and hypnotic conditions for the grouped values. Hypnotic susceptibility, evaluated prior to the immersions, was not significantly correlated with the change in thermal balance or rectal temperature measurements evaluated between control and hypnotic immersions. Although the rating of perceived exertion during both exercise phases were similar for both immersions, subjects' perceived thermal sensation was reduced during the second rest phase of the hypnotic immersions when compared with the control immersion. Although the majority of subjects did not exhibit a hypnotic-induced alteration in thermoregulatory responses during immersion, 3 individuals seemed to respond to hypnosis, but in a manner that accentuated heat loss. These results suggest that the post-hypnotic training techniques employed in the present study did not enhance performance in divers during immersion in 25 C. GRA

N90-18141# Boston Univ., MA. Center for Adaptive Systems.
VISUAL PERCEPTION OF STRUCTURE FROM MOTION Annual Technical Report, 1 Nov. 1988 - 31 Oct. 1989
James T. Todd 20 Nov. 1989 6 p
(Grant AF-AFOSR-0016-89; AF Proj. 2313)
(AD-A216416; AFOSR-89-1785TR) Avail: NTIS HC A02/MF A01 CSCL 06/4

The research performed by James Todd during the past year of AFOSR support has examined the ability of human observers to perceive various aspects of a moving object's 3-D structure from minimal apparent motion sequences. This research has provided a strong body of evidence that the perceptual analysis of 3-D structure from motion is apparently restricted to first order temporal relations. That is to say, when all other factors are optimized, perceptual performance does not improve as the number of discrete frames in an apparent motion sequence is increased beyond two. This research has been accompanied, moreover, by a theoretical analysis of the particular properties of 3-D structure that can be computed from first order temporal relations. The analysis makes specific predictions about which tasks can or cannot be performed accurately by human observers, and these predictions are in strong agreement with the psychophysical data. GRA

N90-18142# Naval Health Research Center, San Diego, CA.
PSYCHOPHYSIOLOGICAL CORRELATES OF HUMAN ADAPTATION IN ANTARCTICA Interim Report
L. A. Palinkas, E. K. Gunderson, and R. G. Burr 1989 34 p
(AD-A216679; NHRC-89-5) Avail: NTIS HC A03/MF A01 CSCL 05/8

Previous research has pointed to social, psychological, and occupational characteristics of Antarctic station personnel as contributing to variations in emotional symptoms commonly experienced during the prolonged isolation of the winter-over period. However, little is known of the influence of specific personality characteristics and the severity of the station environment, either independently or in combination, on these symptoms. This paper examines the social, psychological, and environmental correlates of the psychophysiological symptoms associated with wintering-over in Antarctica and the extent to which these correlates can be used to predict the severity of symptomatology during the winter-over period. Station latitude, altitude, mean annual temperature, were associated with depression and insomnia at the beginning of winter and depression, hostility, and anxiety at the end of the winter. Environmental severity was a independent predictor of hostility and anxiety at the end of winter. Except for insomnia, however, the more severe the environment, the less severe the symptoms. Age was inversely associated with depression and anxiety at the beginning of winter and hostility throughout the winter. Results indicate some form of adaptation to environmental conditions appears to be taking place with respect to psychophysiological symptoms. GRA

N90-18143# New York Univ. Medical Center. Dept. of Psychiatry.
COMPUTING WITH NEURAL MAPS: APPLICATION TO PERCEPTUAL AND COGNITIVE FUNCTIONS Annual Report, 8 Jan. 1988 - 31 Jul. 1989
Eric Schwartz 24 Oct. 1989 5 p
(Grant AF-AFOSR-0275-88; AF Proj. 2313)
(AD-A216689; AFOSR-89-1826TR) Avail: NTIS HC A01/MF A01 CSCL 05/8

During the past year, we have completed two important steps in our program for understanding the biological and computational significance of patterns of spatial mapping in the brain. First, we have found a simple algorithm which is capable of describing and synthesizing the patterns of ocular dominance columns and orientation columns in the cat and monkey. This algorithm is controlled by a small number of parameters, and we show that it produces patterns which are similar to those in our lab, and elsewhere, obtained from animal experimentation. Moreover, we show that a number of previously published algorithms for similar purposes can be shown to be equivalent to our algorithm. The significance of this work is that we can now describe and synthesize some of the major architectural features of cat and monkey sensory cortex with high accuracy. In addition, we have obtained some insight into the essential simplicity of these patterns. This work is currently in press in Biological Cybernetics. In addition, we have developed an algorithm for pattern recognition based on the multiple, parallel two-dimensional mapping of the input data. We view this as an important step in our goal of developing insight into the use of multiple, parallel sensory mappings in the brain. We believe that this algorithm is the first pattern recognition algorithm to make explicit use of the kind of data format which is characteristic of the brain. GRA

N90-18144# Naval Medical Research Inst., Bethesda, MD.
ALTERATIONS IN THE METABOLIC AND SYMPATHETIC RESPONSE TO COLD EXPOSURE AFTER COLD AIR ACCLIMATION Technical Report, Oct. 1985 - Sep. 1993
R. L. Hesslink, Jr., D. W. Armstrong, III, K. Kowalski, L. D. Allen, and H. L. Reed, II 11 Dec. 1989 25 p Sponsored by Naval Medical Research and Development Command, Bethesda, MD
(AD-A216817; NMRI-89-93) Avail: NTIS HC A02/MF A01 CSCL 06/4

The armed services, primarily the Navy and Coast Guard, are tasked with maintaining free passage and security in many geographical locations encompassing tropical and polar conditions. While personnel performance in heat has been well studied and ameliorative guidelines implemented, little is known about performance and survival in the cold. Acute cold exposure elicits frank shivering concomitant with a short-term elevation in basal metabolism. Extended cold exposure can produce mild to severe hypothermia resulting in reduced cognitive function and manual dexterity, thus, having a tremendous effect on mental and physical performance. Moreover, personal safety and health can be compromised in such environments. The ability to adapt to these cold climates and possibly improve one's performance has been extensively investigated. There is strong evidence that localized

cold adaptation can occur over many years of exposure. Whether this adaptation is due to local factors, central factors, or both is not clear. The mechanism responsible for whole body cold adaptation is not clearly understood, but it is generally believed that various types of whole body cold adaptation are possible. Serum triiodothyronine (T3) is the primary hormone involved with many thermoregulatory and adaptive phenomena. GRA

N90-17612# Rouen Univ. (France). Lab. de Toxicologie.
METHOD FOR THE EVALUATION OF TOXICITY OF COMBUSTION PRODUCTS FROM AIRCRAFT CABIN MATERIALS: ANALYSIS AND RESULTS [METHODE D'EVALUATION DE LA TOXICITE DES PRODUITS DE THERMOLYSE DES MATERIAUX DE CABINE AVION ANALYSE DES RESULTATS]
J. M. Jouany and M. Favand (Centre d'Essais Aeronautique Toulouse, France) *In* AGARD, Aircraft Fire Safety Oct. 1989 8 p In FRENCH (For primary document see N90-17581 10-03)
Copyright Avail: NTIS HC A18/MF A03; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

N90-17617# Royal Air Force Inst. of Pathology and Tropical Medicine, Aylesbury (England).
THE INVESTIGATION OF PARTICULATE MATTER IN THE LUNGS OF SMOKE INHALATION DEATH VICTIMS
I. R. Hill and B. P. Michelson *In* AGARD, Aircraft Fire Safety Oct. 1989 9 p (For primary document see N90-17581 10-03)
Copyright Avail: NTIS HC A18/MF A03; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

N90-17618# Royal Albert Edward Infirmary, Wigan (England).
THE IMPORTANCE OF PATHOPHYSIOLOGICAL PARAMETERS IN FIRE MODELLING OF AIRCRAFT ACCIDENTS
John S. S. Stewart *In* AGARD, Aircraft Fire Safety Oct. 1989 12 p (For primary document see N90-17581 10-03)
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N90-17619# Huntingdon Research Centre Ltd. (England).
MODELLING TIME TO INCAPACITATION AND DEATH FROM TOXIC AND PHYSICAL HAZARDS IN AIRCRAFT FIRES
David A. Purser *In* AGARD, Aircraft Fire Safety Oct. 1989 13 p (For primary document see N90-17581 10-03)
Copyright Avail: NTIS HC A18/MF A03; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

53 BEHAVIORAL SCIENCES

Includes psychological factors; individual and group behavior; crew training and evaluation; and psychiatric research.

N90-18145 Washington Univ., Seattle.
SENSITIVITY OF THE PERIPHERAL VISION TO SIMULATED AIRCRAFT ASCENT AND DESCENT Ph.D. Thesis
David Andrew Wheeler 1989 50 p
Avail: Univ. Microfilms Order No. DA9000332

In an effort to decrease the central vision workload in pilots, aircraft designers are developing displays which present information in the peripheral vision. Described here are the results of experiments testing the effects of four display parameters on the ability of subjects to detect changes in upward and downward movement in the peripheral vision as a possible mode of information presentation. Subjects performed a tracking task in the central visual field. At the same time, in the peripheral vision (26 to 69 degrees visual angle), dots were moving toward the subjects, thus forming an information display. Thresholds for detecting changes in direction of dot movement in the peripheral display were measured. The results indicated that changes in direction of motion are detectable using only the peripheral vision and that threshold is highly dependent upon display parameters. These results suggest that, with appropriate display parameters, the peripheral vision is a possible location for a display of altitude change information in aircraft. Dissert. Abstr.

N90-18146# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Systems and Logistics.
A COMPARISON OF MICROCOMPUTER TRAINING METHODS AND SOURCES M.S. Thesis
David M. Kondas Sep. 1989 113 p
(AD-A216349; AFIT/GCA/LSQ/89S-7) Avail: NTIS HC A06/MF A01 CSCL 05/9

The purpose of this study was to evaluate the methods and sources of microcomputer training currently used in the Air Force in terms of their overall value to the job, training effectiveness, and level of competency achieved upon training completion. The three methods studied were classroom instruction, video-based training, and computer-based training (CBT). The three sources studied were in-house training functions, government-contracted training, and private (e.g., colleges and universities). One hundred and fifty-one government employees rated each method and source of PC training they had experienced. Classroom training was found to be the most often used and the most popular method of PC training, regardless of source. The preference of delivery method was classroom, CBT, then video-based training, regardless of source. GRA

N90-17613# Cranfield Inst. of Tech., Bedford (England). Applied Psychology Unit.
PASSENGER BEHAVIOUR IN AIRCRAFT EMERGENCIES INVOLVING SMOKE AND FIRE
Claire Harrison and Helen Muir *In* AGARD, Aircraft Fire Safety Oct. 1989 14 p (For primary document see N90-17581 10-03)
Copyright Avail: NTIS HC A18/MF A03; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

N90-17615# Lufthansa German Airlines, Frankfurt (Germany, F.R.). Emergency Training.
FLIGHT CREW TRAINING FOR FIRE FIGHTING
Ernst-Albrecht Limley *In* AGARD, Aircraft Fire Safety Oct. 1989 6 p (For primary document see N90-17581 10-03)
Copyright Avail: NTIS HC A18/MF A03; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

54 MAN/SYSTEM TECHNOLOGY AND LIFE SUPPORT

Includes human engineering; biotechnology; and space suits and protective clothing.

For related information see also *16 Space Transportation.*

N90-18147*# North Carolina State Univ., Raleigh.
REGULATION OF NITROGEN UPTAKE AND ASSIMILATION: EFFECTS OF NITROGEN SOURCE, ROOT-ZONE pH, AND AERIAL CO2 CONCENTRATION ON GROWTH AND PRODUCTIVITY OF SOYBEANS
C. D. Raper and L. Tolley-Henry Dec. 1989 71 p
(Contract NCC2-101)
(NASA-CR-177546; NAS 1.26:177546) Avail: NTIS HC A04/MF A01 CSCL 06K

An important feature of controlled-environment crop production systems such as those to be used for life support of crews during space exploration is the efficient utilization of nitrogen supplies. Making decisions about the best sources of these supplies requires research into the relationship between nitrogen source and the

physiological processes which regulate vegetative and reproductive plant growth. Work done in four areas within this research objective is reported: (1) experiments on the effects of root-zone pH on preferential utilization of NO3(-) versus NH4(+) nitrogen; (2) investigation of processes at the whole-plant level that regulate nitrogen uptake; (3) studies of the effects of atmospheric CO2 and NO3(-) supply on the growth of soybeans; and (4) examination of the role of NO3(-) uptake in enhancement of root respiration.
Author

N90-18148# Defence Research Establishment, Ottawa (Ontario). Protective Sciences Div.
SOME PRACTICAL ADVICE ON COLD WEATHER CLOTHING
B. Farnworth Aug. 1989 16 p
(AD-A215936; DREO-TN-89-21) Avail: NTIS HC A03/MF A01 CSCL 05/8

Considerable research and development has been carried out on cold weather clothing at the Defense Research Establishment Ottawa. This paper explains in laymen's language, the practical knowledge gained in the course of this work. It deals in turn with the five elements of good winter clothing design, thickness, dryness, wind proofness, whole-body coverage and flexibility. It concludes with explanations of how breathable fabrics, wicking fabrics and aluminized materials work and how practical they are. GRA

N90-18149# Navy Experimental Diving Unit, Panama City, FL.
INSULATION, COMPRESSIBILITY AND ABSORBENCY OF DRY SUIT UNDERGARMENTS Final Report
John A. Sterba, R. Scott Hanson, and Joseph F. Stiglich Aug. 1989 26 p
(AD-A215944; NEDU-10-89) Avail: NTIS HC A03/MF A01 CSCL 05/8

Recent selection of new undergarments (U/G) for cold water diving has been based on anecdotal reports. Previous studies revealed hydrophobic microfibrous material (Thinsulate) to be superior in both insulation when wet and compressibility compared to open-cell foam. The objectives of this study included comparing Thinsulate against the new U/G materials in a controlled, unmanned study. After preliminary testing of 39 U/G composites, nine U/G were chosen: four using arctic fleece, radiant barrier and both Thinsulate and polyester battings from Defense Marketing Consultants (DMC), four using Thinsulate M-400 and M-600 from Diving Unlimited International (DUI) and the Flectalon U/G composite from Arktis Outdoor Products. Dry U/G per unit thickness showed few differences. Saturated with water, the superior U/G, per se, were Flectalon, DUI M-600 and one DMC U/G using Dupont Dacron-II batting. The superior wet U/G, per unit thickness, included the above and M-400 DUI U/G. In conclusion, rating compressibility, absorbency and insulation (wet), the superior U/G included Flectalon and DUI U/G, M-400 and M-600 weights. DMC U/G were ranked next, primarily due to high absorbency. The DMC radiant barrier did not significantly affect insulation by contributing any reflected radiant energy based upon the small temperature gradient between skin and water. GRA

N90-18150# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
PARETO OPTIMIZATION DESIGN TECHNIQUES FOR THE AFIT (AIR FORCE INSTITUTE OF TECHNOLOGY)/AAMRL (ARMSTRONG AERONAUTICAL MEDICAL RESEARCH LABORATORY) ANTHROPOMORPHIC ROBOTIC MANIPULATOR M.S. Thesis
Jerrel D. Tumlin, Jr. Dec. 1989 161 p
(AD-A216178; AFIT/GCS/ENC/89D-3) Avail: NTIS HC A08/MF A01 CSCL 12/9

A method to optimize a robotic parallel manipulator configuration using Pareto Optimization techniques was developed. Pareto optimization is a cooperative effort between design parameters. The design parameters to be optimized included the payload mass, the length of the manipulator link labelled 12, and the prescribed time for the manipulator to move a prescribed distance. Three functionals were computed for design optimization. These included the mechanical efficiency of the system, the maximum value of torque for motor one, and the maximum value of torque for motor two. A functional analysis was performed using two trajectories for the manipulator; a horizontal trajectory and a vertical trajectory. A combination of these paths allows the manipulator to reach anywhere within its workspace. Algorithms were developed for computing each of the functionals when changing any of the design parameters. When the horizontal path was traversed, mechanical efficiency was zero, thus total input work of the manipulator was evaluated. The sensitivities of the design parameter changes were evaluated for optimization. When a horizontal path was followed, only the link 1 (2) length had changing sensitivity values. Sensitivity changes occurred for all of the design parameters for a vertical trajectory. GRA

N90-17614# Air Transport Users Committee, London (England). Air Transport Users Committee.
SMOKEHOODS DONNED QUICKLY. THE IMPACT OF DONNING SMOKEHOODS ON EVACUATION TIMES
J. H. B. Van *In* AGARD, Aircraft Fire Safety Oct. 1989 12 p (For primary document see N90-17581 10-03)
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N90-17616# Civil Aeromedical Inst., Oklahoma City, OK. Protection and Survival Lab.
THE RESEARCH PROGRAM AT THE CIVIL AEROMEDICAL INSTITUTE CONCERNING PROTECTIVE BREATHING EQUIPMENT FOR USE BY CREW AND PASSENGERS IN AN AVIATION SMOKE/FUME ENVIRONMENT
E. Arnold Higgins *In* AGARD, Aircraft Fire Safety Oct. 1989 7 p (For primary document see N90-17581 10-03)
Copyright Avail: NTIS HC A18/MF A03; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

55 SPACE BIOLOGY

Includes exobiology; planetary biology; and extraterrestrial life.

No abstracts in this category.

59 MATHEMATICAL AND COMPUTER SCIENCES (GENERAL)

N90-18151*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
ADVANCING AUTOMATION AND ROBOTICS TECHNOLOGY FOR THE SPACE STATION FREEDOM AND FOR THE US ECONOMY Progress Report No. 7, Apr. 1988 - Sep. 1988
Sep. 1988 37 p
(NASA-TM-101691; NAS 1.15:101691) Avail: NTIS HC A03/MF A01 CSCL 05H

In April 1985, as required by Public Law 98-371, the NASA Advanced Technology Advisory Committee (ATAC) reported to Congress the results of its studies on advanced automation and robotics technology for use on the Freedom space station. This material was documented in the initial report (NASA Technical Memorandum 87566). A further requirement of the law was that ATAC follow NASA's progress in this area and report to Congress semiannually. This report is the seventh in a series of progress updates and covers the period between April 1, 1988 and September 30, 1988. NASA has accepted the basic recommendations of ATAC for its Space Station Freedom efforts. ATAC and NASA agree that the thrust of Congress is to build an

advanced automation and robotics technology base that will support an evolutionary Space Station Freedom program and serve as a highly visible stimulator, affecting the U.S. long-term economy. The progress report identifies the work of NASA and the Freedom study contractors. It also describes research in progress, and it makes assessments of the advancement of automation and robotics technology on the Freedom space station. Author

N90-18152*# Institute for Computer Applications in Science and Engineering, Hampton, VA.
A SCHEME FOR SUPPORTING DISTRIBUTED DATA STRUCTURES ON MULTICOMPUTERS Final Report
Seema Hiranandani, Joel Saltz, Harry Berryman, and Piyush Mehrotra Jan. 1990 14 p Presented at the 17th Annual Symposium on Computer Architecture Prepared in cooperation with Yale Univ., New Haven, CT Submitted for publication
(Contracts NAS1-18605; N00014-86-K-0310)
(NASA-CR-181987; ICASE-IR-9; NAS 1.26:181987) Avail: NTIS HC A03/MF A01 CSCL 12A

A data migration mechanism is proposed that allows an explicit and controlled mapping of data to memory. While read or write copies of each data element can be assigned to any processor's memory, longer term storage of each data element is assigned to a specific location in the memory of a particular processor. The proposed integration of a data migration scheme with a compiler is able to eliminate the migration of unneeded data that can occur in multiprocessor paging or caching. The overhead of adjudicating multiple concurrent writes to the same page or cache line is also eliminated. Data is presented that suggests that the scheme may be a pratical method for efficiently supporting data migration. Author

60 COMPUTER OPERATIONS AND HARDWARE

Includes hardware for computer graphics, firmware, and data processing.

For components see *33 Electronics and Electrical Engineering.*

N90-18153# Royal Signals and Radar Establishment, Malvern (England).
A FLEXIBLE BASIS FOR SOFTWARE CONFIGURATION MANAGEMENT
M. Stanley and P. D. Hammond Feb. 1988 29 p
(RSRE-Memo-4127; BR105560) Copyright Avail: NTIS HC A03/MF A01

Software configuration management is a necessary part of any project support environment. What software configuration management aims to achieve is discussed as is a basis from which a software configuration management system can be developed. The proposed basis is illustrated by reference to the software configuration management features demonstrated in the Flex programming support environment, developed at RSRE Malvern. Author

N90-18154*# Michigan Univ., Ann Arbor. Real-Time Computing Lab.
STUDY ON ADVANCED INFORMATION PROCESSING SYSTEM Final Report
Kang G. Shin and Jyh-Charn Liu 2 Mar. 1990 34 p
(Grant NAG1-981)
(NASA-CR-186342; NAS 1.26:186342) Avail: NTIS HC A03/MF A01 CSCL 09B

Issues related to the reliability of a redundant system with large main memory are addressed. In particular, the Fault-Tolerant Processor (FTP) for Advanced Launching Systems (ALS) is used as a basis for the presentation. When the system is free of latent faults, the probability of system crash due to multiple channel faults is shown to be insignificant even when the outputs of computing channels are infrequently voted on. In particular, using channel error maskers (CEMs) is shown to improve reliability more effectively than increasing the number of channels for applications with long mission times. Even without using a voter, most memory errors can be immediately corrected by CEMs that are implemented with conventional coding techniques. In addition to their ability to enhance system reliability, CEMs - with a low hardware overhead - can be used to reduce not only the need of memory re-alignment, but also the time required to re-align channel memories in case, albeit rare, such a need arises. Using CEMs, two schemes, called Scheme 1 and Scheme 2, were developed to solve the memory re-alignment problem. In both schemes, most errors are corrected by CEMs, and the remaining errors are masked by a voter. Author

N90-18155# Penguin Software, Inc., Long Beach, CA.
A MICROCODE COMPILER THAT RUNS ON THE IBM AT AND SUPPORTS CASCADABLE MICROCOMPUTERS, PART 2 Final Report, 23 Sep. 1987 - 22 Sep. 1989
Thomas H. Weight 11 Nov. 1989 47 p
(Contract DAAD07-87-C-0119)
(AD-A215889) Avail: NTIS HC A03/MF A01 CSCL 12/5

PENGUIN SOFTWARE, Inc. has developed a retargetable microcode compiler. The approach does not have a fixed machine independent language, but allows the user to develop a language specific to each particular target machine. PENGUIN SOFTWARE's Microcode Compiler starts out with an underlying meta-assembler and builds up a higher level language capability around it. This capability allows the user to incorporate knowledge of target machine design into the language definition, and thus avoid the necessity for resource allocation and code compaction in application program. This approach results in a microcode development tool which is a very low risk, very fast, and is capable of supporting virtually any digital hardware architecture. GRA

N90-18156# Massachusetts Inst. of Tech., Cambridge. Lab. for Computer Science.
CACHE FOR MULTI-THREADED PROCESSORS ON A SPLIT-TRANSACTION BUS
Ingmar Vuong-Adlerberg (Institut National de Recherche d'Informatique et d'Automatique, Le Chesnay, France) Nov. 1989 30 p
(Contracts N00014-83-K-0125; N00014-89-J-1988)
(AD-A216404; MIT/LCS/TR-466) Avail: NTIS HC A03/MF A01 CSCL 12/7

A multi-threaded processor has several sets of registers, and therefore can keep several tasks in a state of being ready to run. This ability to combine several independent instruction streams prevents such a processor from getting systematically blocked upon every cache miss involving a long memory access. Unfortunately, upon a cache miss, conventional caches remain unavailable for further processor requests until the cache miss is completely processed. This of course defeats the purpose of this kind of architecture, since memory accesses performed by the other threads might hit in the cache and therefore succeed. Instead, the processor stays idle. This article describes a cache architecture capable of servicing processor requests even while a memory access is currently being performed. For further efficiency reasons, this cache communicates with the memory via a split transaction bus. These two features increase substantially the amount of state information to be kept along with each cache entry, making the cache automaton and protocol quite complicated. We detail the kind of consistency provided by our cache, along with a proof of its validity. As very little theoretical support exists for this kind of proof, we also present a formalism that we developed in the course of this project, and which is suitable for expressing statements of consistency. GRA

61 COMPUTER PROGRAMMING AND SOFTWARE

Includes computer programs, routines, alogorithms, and specific applications, e.g., CAD/CAM.

N90-18157# National Academy of Sciences - National Research Council, Washington, DC. Commission on Engineering and Technical Systems.
ADAPTING SOFTWARE DEVELOPMENT POLICIES TO MODERN TECHNOLOGY Final Report, Jun. - Aug. 1988
Jul. 1989 104 p
(AD-A213391) Avail: NTIS HC A06/MF A01 CSCL 12/5

The problem of developing reliable software that is capable of performing its intended function has persisted since the advent of digital computers. The subject has been reviewed many times. Are newer methods of software development now being introduced for large, high technology systems outstripping conventional software acquisition techniques and policies. The committee reviewed recent software studies to learn why they did not adequately solve the problem. Also, the committee assessed current and past development programs, investigated methods for the user and developer to work more closely, evaluated software process models as alternatives to the water fall model, evaluated incremental development, evolutionary development, prototyping, etc. GRA

N90-18158# Office of Software Development, Falls Church, VA. Federal Software Management Support Center.
PREPARING SOFTWARE CONVERSION STUDIES
Dec. 1989 62 p
Avail: NTIS HC A04/MF A01

The purpose of this document is to provide Government agencies with a guideline for preparing software conversion studies. Software conversion, as defined in FIRMR 201-2.001, is the transformation, without functional change, of computer programs or data elements to permit their use on a replacement or changed ADP equipment system or teleprocessing service. In accordance with FIRMR 201-30.012-1, a software conversion study is required for all acquisitions to ensure that the user's needs are met competitively at the lowest overall cost, price, and other factors considered including the cost and other factors associated with conversion activities. A comprehensive software conversion study is required for each augmentation or replacement ADPE or ADP services acquisition if one of the following conditions exists: (1) The estimated purchase price of the equipment, system, or estimated system life cost of the ADP service is expected to exceed $2.5 million; or (2) The cost of conversion is to be used as the primary justification for a compatibility-limited requirement when the estimated value of the acquisition exceeds $300,000. The study should be prepared as early in the procurement process as possible since it is one of the major aids in determining the procurement strategy of the agency. This document is an update of report number OIT/FCSC-84/001, Preparing Software Conversion Studies, (dated Jan. 1984). It contains an outline for software conversion studies that the Federal Software Management Support Center has found to be most successful. Each chapter required by the FIRMR is specified. Section 1 contains the introduction to the software conversion study; Section 2 describes the current environment; Section 3 describes the target environment; Section 4 documents conversion cost estimating; Section 5 contains a summary of findings; and Section 6 provides the procurement and implementation schedule. Author

N90-18159# Princeton Univ., NJ. Dept. of Computer Science.
FINDING MINIMUM-COST FLOWS BY DOUBLE SCALING
Ravindra K. Ahuja, Andrew V. Goldberg, James B. Orlin, and Robert E. Tarjan (Bell Telephone Labs., Inc., Murray Hill, NJ.) Jun. 1988 31 p Sponsored in part by Analog Devices; Apple Computer, Inc.; Prime Computer, Inc.; and IBM
(Contract N00014-87-K-0467; NSF ECS-84-51517; NSF CCR-88-58097; NSF DCR-86-05962; AF-AFOSR-0088-88)
(AD-A214498; PU-CS-TR-164-88) Avail: NTIS HC A03/MF A01 CSCL 09/2

Several researchers have recently developed new techniques that give fast algorithms for the minimum cost flow problem. Several of these techniques are combined to yield an algorithm running in O(nm log log U(nC)) time on networks with n vertices, m arcs, maximum arc capacity U, and maximum arc cost magnitude C. The major techniques used are the capacity scaling approach of Edmonds and Karp, the excess scaling approach of Goldberg and Tarjan, and the dynamic tree data structure of Sleator and Tarjan. For nonsparse graphs with large maximum arc capacity, a similar but slight better bound is obtained. A slightly better bound is also obtained for the (uncapacitated) transportation problem. In addition, a capacity bounding approach to the minimum cost flow problem is discussed. Author

N90-18160# California Univ., San Diego, La Jolla. Dept. of Electrical Engineering and Computer Sciences.
HYBRID (OPTICAL/ELECTRONIC) COMPUTING AND DIGITAL OPTICAL COMPUTING Final Technical Report, 1 Sep. 1985 - 31 Aug. 1988
Sing H. Lee 2 Oct. 1989 29 p
(Grant AF-AFOSR-0371-85; AF Proj. 2305)
(AD-A214502; AFOSR-89-1324TR) Avail: NTIS HC A03/MF A01 CSCL 09/2

Hybrid optical analog/electronic computing is performed for optical image processing, optical pattern recognition and optical solution of partial differential equations. For example, image processing was designed and fabricated for space variant filters to optically implement numerous space variant transformation (e.g., Hough transform for detection of high order parametric curves, coordinate transforms to detect rotation and scale invariant features of images, etc.). For spike removal from noisy images, one can develop a new parallel algorithm suitable for optical/analog electronic hybrid implementation. This parallel algorithm is space variant and performs better than the space invariant low pass filter and the time consuming median filter. In digital optical computing research, nonlinear optical devices were developed and their uses in parallel architectures for implementation of parallel algorithms were studied. The nonlinear optical devices are based on integrating silicon with Pb-based Lanthanum doped Zirconate Titanates (PLZT) low pressure chemical vapor deposition techniques to deposit polycrystalline Si onto the electro-optic PLZT substrate and then recrystallizing the polysilicon using an Ar+ laser are used to produce single crystal silicon grains, to fabricate and test a 12 x 12 electrically addressed spatial light modulator (SLM) array and a 16 x 16 optically addressed SLM array. Optical parallel computing architectures are investigated by different interconnection topologies and holographic optical elements are generated to implement fully interconnected and hypercube interconnected topology. Author

N90-18161# Naval Postgraduate School, Monterey, CA. Dept. of Operations Research.
DYNAMIC FACTORIZATION IN LARGE-SCALE OPTIMIZATION Ph.D. Thesis
Michael Paul Olson Jun. 1989 185 p
(AD-A214568) Avail: NTIS HC A09/MF A01 CSCL 12/4

Factorization is an approach to linear programming (LP) in which the algebraic elements of the LP tableau are organized in such a way that a large portion of the tableau may be represented implicitly and generated from the remaining explicit part. In dynamic row factorization, the row structure of the LP model instance influences the algebraic structure of the tableau, and the dimension of the algebraic elements may change as the solution progresses. We present three algorithms motivated by this approach, each resulting from a different LPL model row structure: generalized upper bound (GUB) rows, pure network rows and generalized network rows. We describe implementations of all three algorithms, specifying data structures for tableau and basis inverse representations and detailing procedures for manipulation and update of these representations. GRA

N90-18162# Ada Joint Program Office, Arlington, VA.
PROCEEDINGS OF THE 4TH ANNUAL Ada SOFTWARE ENGINEERING EDUCATION AND TRAINING SYMPOSIUM
Jun. 1989 231 p Symposium held in Houston, TX, 13-15 Jun. 1989
(AD-A214663) Avail: NTIS HC A11/MF A02 CSCL 12/5

Proceedings of this conference include: Software maintenance exercises for a software engineering project course; Software engineering and Ada database system (SEAD); Why Ada is (Still) My favorite data structures language; Process control training for a software engineering team; Ada training at Keesler Air Force Base; Integrating Ada into the University curriculum: Academia and Industry: Joint responsibility; Making the case for tasking through comparative study of concurrent languages; Teaching the Ada tasking model to experienced programmers: Lessons learned; Ada: Helping executives understand the issues; The pedagogy and pragmatics of teaching Ada as a software engineering tool; Motivation and retention issues in teach Ada: How will students learn software engineering when their only goal is Ada on their resume; Software design with Ada: A vehicle for Ada instruction; Transitioning to engineered Ada in the small liberal arts college; A HyperCard prototype of a CASE tool in support of teaching the Berard Method of object oriented development in an undergraduate course. GRA

N90-18163# Princeton Univ., NJ. Dept. of Computer Science.
FASTER SCALING ALGORITHMS FOR GENERAL GRAPH MATCHING PROBLEMS
Harold N. Gabow and Robert E. Tarjan (Bell Telephone Labs., Inc., Murray Hill, NJ.) 11 Apr. 1989 50 p Sponsored in part by Bell Telephone Labs., Inc., Murray Hill, NJ
(Contract N00014-87-K-0467; NSF DCR-85-1191; NSF CCR-88-15636; NSF DCR-86-05962)
(AD-A215112; CS-TR-222-89) Avail: NTIS HC A03/MF A01 CSCL 12/1

This paper presents an algorithm for minimum cost matching on a general graph with integral edge costs, that runs in time close to the best known bound for cardinality matching. Specifically, let n, m and N denote the number of vertices, number of edges, and largest magnitude of a cost, respectively. Other applications of the new algorithm are given, including an efficient implementation of Christofides' traveling salesman approximation algorithm and efficient solutions to update problems that require the linear programming duals for matching. GRA

N90-18164# Consiglio Nazionale delle Ricerche, Frascati (Italy). Ist. di Fisica dello Spazio Interplanetario.
SOFTWARE FOR IMAGE TREATMENT OF THE FORCE SYSTEM OPERATING AT THE IFSI [SOFTWARE PER IL TRATTAMENTO DI IMMAGINI OPERANTE SUL SISTEMA FORCE DELL'IFSI]
C. Gariazzo, F. Tripodi, and V. Formisano Oct. 1988 91 p In ITALIAN Original contains color illustrations
(IFSI-88-15; ETN-90-96154) Avail: NTIS HC A05/MF A01

The image processing software adopted to work with the PDOS operating system in the FORCE computer for astronomical work is described. Ram buffers are created in the 7 megabyte available memory. Each of the four buffers holds an image at 16 bit/pixel corresponding to the 384 by 576 pixels of the charge coupled devices raw images. Routines and commands are detailed. ESA

N90-18165# Materials Research Labs., Ascot Vale (Australia).
THE PROCEDURES FOR EASY RUNNING OF THE HULL COMPUTER CODE UNDER VMS
Ross J. Kummer 1989 55 p
(MRL-GD-0023; AR-005-710) Avail: NTIS HC A04/MF A01

Version 121 of the HULL computer code was installed on a VAX 8700 at the Materials Research Laboratory (MRL). The complex command procedures that were written to provide an easy interface for running HULL on the VAX system are explained. Full instruction guides are included, with installation details to provide easy implementation of the procedures at other VAX sites. Author

N90-18166*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
RASTER METAFILE AND RASTER METAFILE TRANSLATOR
Nancy L. Taylor, Eric L. Everton, Donald P. Randall, Raymond L. Gates, and Kristi M. Skeens (Computer Sciences Corp., Hampton, VA.) Sep. 1989 116 p
(NASA-TM-102588; NAS 1.15:102588) Avail: NTIS HC A06/MF A01 CSCL 09B

The intent is to present an effort undertaken at NASA Langley Research Center to design a generic raster image format and to develop tools for processing images prepared in this format. Both the Raster Metafile (RM) format and the Raster Metafile Translator (RMT) are addressed. This document is intended to serve a varied audience including: users wishing to display and manipulate raster image data, programmers responsible for either interfacing the RM format with other raster formats or for developing new RMT device drivers, and programmers charged with installing the software on a host platform. Author

N90-18167# New York Univ., New York. Inst. of Mathematical Sciences.
[RESEARCH AT NEW YORK UNIVERSITY'S ULTRACOMPUTER RESEARCH LABORATORY] Progress Report, 1989
Allan Gottlieb Dec. 1989 11 p
(Contract DE-FG02-88ER-25052)
(DE90-005471; DOE/ER-25052/2) Avail: NTIS HC A03/MF A01

Research at NYU Ultracomputer Laboratory is discussed for the following areas: applications; network simulation; analytical modeling; computer architecture; operating systems; algorithms; programming languages and compilers; and debugging. DOE

N90-18168# Instituto de Engenharia Nuclear, Rio de Janeiro (Brazil). Div. de Mecanica Estrutural.
POS2D: A GRAPHIC PROGRAM FOR ANALYSING AXISYMMETRIC AND TWO-DIMENSIONAL STRUCTURES
Julio Richardo BarretoCruz and Ylisses PereiradeAraujo 12 Jan. 1989 11 p In PORTUGESE
(DE90-608884; IEN-DERE-DIMEC-001/89) Avail: NTIS (US Sales Only) HC A03/MF A01

The implementation of a computer program for graphic post processing of data related to the structure analysis is presented. This program uses the finite element method. DOE

N90-18169# Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).
A MONOTONE SURROGATE ALGORITHM FOR THE 0-1 MULTIKNAPSACK PROBLEM
Luiz Antonio NogueiraLorena Sep. 1989 16 p Presented at the 14th IFIP Conference on System Modelling and Optmization, Leipzig, German Democratic Republic, 3-7 Jul. 1989
(INPE-4933-PRE/1423) Avail: NTIS HC A03/MF A01

An approach for generating a monotone nonincreasing algorithm to the 0 to 1 multiknapsack surrogate relaxation is showed. The work is centralized in controlling the step size of a subgradient type algorithm. A repetition of optimal intermediate values for the surrogate problem is avoided at least at the third consecutive iteration. Computational tests with problems of the literature are presented. Author

N90-18170# Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).
A SYSTEM FOR EXECUTION OF JSD REQUIREMENTS M.S. Thesis
Ana Maria Ambrosio Sep. 1989 199 p In PORTUGUESE; ENGLISH summary
(INPE-4915-TDL/381) Avail: NTIS HC A09/MF A02

The operational approach for software development was suggested as an alternative to the conventional approach (specify, project, and implement). One of the basic principles of the operational approach is the direct execution of the software requirements specification. The Jackson System Development

(JSD) approach is considered as an operational approach and, as such, a language and a scheme are proposed that make possible the execution of JSD specifications. It is also implemented a system that analyzes specifications and allows their execution. Author

N90-18171# Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil). Ministerio da Ciencia e Tecnologia.
LOGICAL ARCHITECTURE
Antonio Francisco Junior Jan. 1989 37 p In PORTUGUESE; ENGLISH summary
(INPE-4792-RPE/585) Avail: NTIS HC A03/MF A01

The objective is to introduce the Prolog language conceptually, to show the intrinsic problems in the execution of Prolog programs on specific machines, and to analyze the current status of logical architectures. Author

N90-18172# Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil). Ministerio da Ciencia e Tecnologia.
AN EXACT ALGORITHM FOR THE p-MEDIAN PROBLEM
Hilcea FerreiraMarengoni, Edson Luiz FrancaSenne, and Luiz Antonio NogueiraLorena Aug. 1989 7 p In PORTUGUESE; ENGLISH summary Presented at the 22nd SBPO Conference, Fortaleza, Brazil, 18-20 Oct. 1989
(INPE-4914-PRE/1415) Avail: NTIS HC A02/MF A01

An exact algorithm for solving the p-median problem based on an integer programming formulation of the problem is presented. A branch and bound algorithm is presented and the bounds are obtained by solving the lagrangian relaxation using the subgradient optimization method. The algorithm is implemented to run on a IBM-PC microcomputer. Author

N90-18173# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
HYPERCUBE EXPERT SYSTEM SHELL-APPLYING PRODUCTION PARALLELISM M.S. Thesis
William A. Harding Dec. 1989 134 p
(AD-A215762; AFIT/GCS/ENG/89D-6) Avail: NTIS HC A07/MF A01 CSCL 12/7

This research investigation proposes a hypercube design which supports efficient symbolic computing to permit real-time control of an air vehicle by an expert system. Design efforts are aimed at alleviating common expert system bottlenecks, such as the inefficiency of symbolic programming languages like Lisp and the disproportionate amount of computation time commonly spent in the match phase of the expert system match-select-act cycle. Faster processing of Robotic Air Vehicle (RAV) expert system software is approached through: (1) fast production matching using the state-saving Rete match algorithm, (2) efficient shell implementation using the C-Programming Language, and (3) parallel processing of the RAV using multiple copies of a serial expert system shell. In this investigation, the serial C-Language Integrated Production System (CLIPS) shell is modified to execute in parallel on the iPSC/2 Hypercube. Speedups achieved using this architecture are quantified through theoretical timing analysis, and comparison with serial architecture performance results, with earlier designs' performance results, with best case results and with goal performance. GRA

N90-18174# BBN Systems and Technologies Corp., Cambridge, MA.
AN INTELLIGENT TOOL FOR THE DESIGN OF PRESENTATIONS: A SYSTEM IDENTIFICATION STUDY Final Report, Mar. - Oct. 1988
Bruce Papazian, R. B. Roberts, Donald J. Redick, Daniel M. Tani, and Richard W. Pew Oct. 1989 186 p
(Contract F30602-87-D-0093)
(AD-A215770; BBN-6932; RADC-TR-89-197) Avail: NTIS HC A09/MF A01 CSCL 12/5

This report summarizes a study to identify the appropriate role of knowledge based technology in the design of user-computer interfaces and to assess the suitability of the published human factors design guidelines as a source of interface design knowledge. In addition to specific recommendations in these areas, the report incorporates a literature review of the following topics: the development of knowledge-based systems, rules-of-thumb concerning the types of problems to which knowledge-based systems have been successfully applied, the general nature of design problem solving, interface design methods, the use of human factors guidelines in interface design, and the state-of-the-art in interface design support tools. GRA

N90-18175# Yale Univ., New Haven, CT. Dept. of Computer Science.
DOMAIN DECOMPOSITION WITH LOCAL MESH REFINEMENT
William D. Gropp and David E. Keyes Aug. 1989 30 p
(Contract N00014-86-K-0310; NSF DCR-85-21451)
(AD-A215806; YALEU/DCS/RR-726) Avail: NTIS HC A03/MF A01 CSCL 12/1

A preconditioned Krylov iterative algorithm is based on domain decomposition for implicit linear system arising from partial differential equation problems which require local mesh refinement. To keep data structures as simple as possible for parallel computing applications, the fundamental computational unit in the algorithm is a subregion of the domain spanned by a locally uniform tensor-product grid, called a tile. This is in contrast to local refinement techniques whose fundamental computational unit is a grid at a given level of refinement. Bookkeeping requirements of grid algorithms are potentially substantial, since consistency of data must be enforced at points of space which may belong to several different grids and the grids are not necessarily of tensor-product type, but more generally, unions thereof. The tile-based domain decomposition approach condenses the number of levels in consideration at each point of the domain to two: a global coarse grid defined by tile vertices only and a local fine grid, where the degree of resolution of the fine grid can vary from tile to tile. Experimentally, it is shown that one global level and one local level provide sufficient flexibility to handle a diverse collection of problems which include irregular regions, non-simply connected regions, non-self adjoint operators, mixed boundary conditions, non-smooth coefficients, or non-smooth solutions. GRA

N90-18176# Naval Ocean Systems Center, San Diego, CA.
KAPSE INTERFACE TEAM (KIT) PUBLIC REPORT, VOLUME 7 Final Report, May - Oct. 1985
D. L. Hayward Oct. 1989 557 p
(AD-A215838; NOSC/TD-552-Vol-7) Avail: NTIS HC A24/MF A03 CSCL 12/5

This report is the seventh in a series and represents evolving ideas and progress of the KAPSE Interface Team (KIT). Partial contents of this report include: Common APSE Interface Set (CAIS); Requirements and Design Criteria (RAC); Interface Analysis and Software Engineering Techniques-Environment Interface Analysis; Interface Analysis and Software Engineering Techniques-Engineering Techniques Design and Implementation Experiences; Interface Analysis and Software Engineering Techniques-Transporting an Ada Software Tool: A Case Study; DoD Requirements and Design Criteria for the Common APSE Interface Set (CAIS); Rationale for the DoD Requirements and Design Criteria for the Common APSE Interface Set (CAIS); and DRAFT Guidelines and Conventions Working Group Ada Tool Transportability Guide. GRA

N90-18177# Naval Ocean Systems Center, San Diego, CA.
KAPSE INTERFACE TEAM (KIT) PUBLIC REPORT, VOLUME 8, PART 1 Final Report, May - Oct. 1985
D. L. Hayward Oct. 1989 476 p
(AD-A215839; NOSC/TD-552-Vol-8-Pt-1) Avail: NTIS HC A21/MF A02 CSCL 12/5

This report is the eighth in a series that is being published by the KAPSE Interface Team (KIT). This series of reports serves to record the activities which have taken place to date and to submit for public review the products that have resulted. The reports should be viewed as snapshots of the progress of the KIT and its companion team, the KAPSE Interface Team from Industry and

Academia (KITIA); everything that is ready for public review at a given time is included. These reports represent evolving ideas, so the contents should not be taken as fixed or final. GRA

N90-18178# Naval Ocean Systems Center, San Diego, CA.
KAPSE INTERFACE TEAM (KIT) PUBLIC REPORT, VOLUME 8, PART 2 Final Report, May - Oct. 1985
D. L. Hayward Oct. 1989 393 p
(AD-A215840; NOSC/TD-552-Vol-8-Pt-2) Avail: NTIS HC A17/MF A03 CSCL 12/5

Topics addressed include: A Distributed CAIS; NASA Space Station Software Requirements; Applying Denotational Semantics to Specifying Kernel Interfaces; Quality Assurance Guidelines; Ada Interoperability Survey; An Investigation of the Common APSE Interface Set (CAIS) on and IBM S/370 Running VM/CMS Implementation of a Prototype CAIS Environment; and PCTE - A Basic for a Portable Common Tool Environment. GRA

N90-18179# Tennessee Univ., Knoxville.
[NONPROCEDURAL IMPLEMENTATION OF MATHEMATICAL PROGRAMMING ALGORITHMS] Final Report, 1 Jan. 1987 - 31 May 1989
James K. Ho 31 May 1989 3 p
(Contract N00014-87-K-0163)
(AD-A216039) Avail: NTIS HC A01/MF A01 CSCL 12/4

The following tasks were accomplished: (1) Implementation began for DECOMPAR, a linear programming decomposition code in FORTRAN to run on the VAX/UNIX based CRYSTAL multicomputer; (2) Documentation continued for DECOMPAR. A large part of our computational work is based on DECOMP, a FORTRAN implementation of the Dantzig-Wolfe decomposition algorithm for block-angular linear programs. This code has evolved into a robust and relatively portable experimental tool for large-scale mathematical programming; (3) Analysis and empirical study of computational strategies for parallel decomposition were made; (4) A multistage, multiproduct material requirements planning problem with capacity constraints, was addressed; (5) The stochastic dynamic traffic assignment problem was addressed. Previously, the PI has shown that a class of non-linear, non-convex dynamic network flow problems can be solved as a sequence of linear programs. The LP's have the staircase structure typical of time-phased problems. A generalization to the case where input traffic at the nodes are stochastic was proposed and analyzed; (6) True shadow prices in linear programming were computed. The optimal values of the dual variables in a LP are true shadow prices (marginal values) only under nondegeneracy; and (7) Nonprocedural implementation of mathematical programming algorithms were addressed. GRA

N90-18180# Massachusetts Inst. of Tech., Cambridge. Lab. for Computer Science.
A HUNDRED IMPOSSIBILITY PROOFS FOR DISTRIBUTED COMPUTING
Nancy A. Lynch Aug. 1989 31 p
(Contracts N00014-85-K-0168; N00014-83-K-0125; NSF CCR-86-11442)
(AD-A216391; MIT/LCS/TM-394) Avail: NTIS HC A03/MF A01 CSCL 12/5

This talk is about impossibility results in the area of distributed computing. In this category, I include not just results that say that a particular task cannot be accomplished, but also lower bound results, which say that a task cannot be accomplished within a certain bound on cost. I started out with a simple plan for preparing this talk: I would spend a couple of weeks reading all the impossibility proofs in our fields, and would categorize them according to the ideas used. Then I would make wise and general observations, and try to predict where the future of this area is headed. That turned out to be a bit too ambitious; there are many more such results than I thought. Although it is often hard to say what constitutes different results, I managed to count over 100 such impossibility proofs and my search wasn't even very systematic or exhaustive. It's not quite as hopeless to understand this area as it might seem from the number of papers. Although there are 100 different results, there aren't 100 different ideas. I thought I could contribute something by identifying some of the commonality among the different results. GRA

N90-18181# Washington Univ., Seattle. Dept. of Applied Mathematics.
NUMERICAL ALGORITHMS FOR PARALLEL COMPUTERS Final Technical Report, 1 May 1986 - 31 Aug. 1989
Loyce M. Adams 31 Aug. 1989 11 p
(Grant AF-AFOSR-0154-86; AF Proj. 2304)
(AD-A216812; AFOSR-89-1685TR) Avail: NTIS HC A02/MF A01 CSCL 12/1

Throughout the duration of this grant, progress has been made on five fronts: analysis of parallel iterative methods using Fourier analysis techniques, preconditioners for linear systems on parallel architectures, numerical grid generation algorithms for fighter aircraft configurations, parallel domain decomposition algorithms for symmetric eigenvalue problems, and parallel language design issues from an applications point of view. GRA

N90-18182# Army Inst. for Research in Management Information and Computer Sciences, Atlanta, GA.
TECHNOLOGY ASSESSMENT OF COMPUTER LANGUAGES
Feb. 1989 15 p
(AD-A216940; ASQBG-I-89-012) Avail: NTIS HC A03/MF A01 CSCL 12/5

The purpose of this paper is to examine the history, assess the current trend, and then provide some insight into the future development of computer languages. To this end, four major sections are provided. Section 1 is a historical perspective of computer languages; Section 2, the trend of today's development; Section 3, a projection of what may be in the 1995 timeframe; and Section 4, the 2010 timeframe. Each section relies heavily on the information from the preceeding section, which is also typical of computer language. Each subsequent language seems to build from the mistakes and strengths of its predecessors. GRA

N90-18183# Los Alamos National Lab., NM.
WRITING PARALLEL, DISCRETE-EVENT SIMULATIONS IN MODSIM: INSIGHT AND EXPERIENCE
David O. Rich and Randy E. Michelsen 11 Sep. 1989 19 p Presented at the ACM SIGPLAN Symposium on Principles and Practice of Parallel Programming, Seattle, WA, 15-16 Mar. 1990
(Contract W-7405-eng-36)
(DE90-001833; LA-UR-89-3104; CONF-900329-1) Avail: NTIS HC A03/MF A01

The Time Warp Operating System (TWOS) has been the focus of much research in parallel simulation. A new language, called ModSim, has been developed for use in conjunction with TWOS. The coupling of ModSim and TWOS provides a tool to construct large, complex simulation models that will run on several parallel and distributed computer systems. As part of the Griffin Project underway here at Los Alamos National Laboratory, there is strong interest in assessing the coupling of ModSim and TWOS from an application-oriented perspective. To this end, a key component of the Eagle combat simulation has been implemented in ModSim for execution on TWOS. In this paper brief overviews of ModSim and TWOS will be presented. Finally, the compatibility of the computational models presented by the language and the operating system will be examined in light of experience gained to date. DOE

62 COMPUTER SYSTEMS

Includes computer networks and special application computer systems.

N90-18184 Missouri Univ., Columbia.
DECOMPOSITION FOR OPTIMAL SYNTHESIS IN A PARALLEL COMPUTING ENVIRONMENT
Vinay Dhirajlal Bhatt 1989 166 p
Avail: Univ. Microfilms Order No. DA8925271

Many practical problems in science and engineering require extensive simplification and abstraction in order to be tractable in currently existing computing environments. Obvious examples are: computational fluid dynamics; nuclear and plasma physics; petroleum reservoir modeling; computer graphics and image processing; and structural synthesis. This research will be useful in these (as well as, other) application fields, but structural synthesis was chosen as the area of application. The research was inspired by a philosophy of design called multilevel decomposition, which enables solution of these problems in a reasonable time. In this approach a complex system (for example, a modern aircraft or automobile) is decomposed into several manageably smaller subsystems. These subsystems are solved independently without losing integrity with the main or parent system and ultimately achieving satisfactory results for the large scale system. In addition to making problem solution more tractable, the decomposition approach is compatible with a typical design office multidisciplinary organization and the parallel or distributed computing technology existing today. Several example problems (including classical problems in the field and practical applications from industry) were used to check the validity of the approach. Dissert. Abstr.

N90-18185# Massachusetts Inst. of Tech., Cambridge. Dept. of Electrical Engineering and Computer Science.
EFFICIENT INTERCONNECTION SCHEMES FOR VLSI AND PARALLEL COMPUTATION Ph.D. Thesis
Ronald I. Greenberg Aug. 1989 147 p Sponsored in part by Fannie and John Hertz Foundation
(Contracts N00014-87-K-0825; N00014-86-K-0593)
(AD-A216405; MIT/LCS/TR-456) Avail: NTIS HC A07/MF A01 CSCL 12/7

This thesis is primarily concerned with two problems of interconnecting components in VLSI technologies. In the first case, the goal is to construct efficient interconnection networks for general-purpose parallel computers. The second problem is a more specialized problem in the design of VLSI chips, namely multilayer channel routing. In addition, a final part of this thesis provides lower bounds on the area required for VLSI implementations of finite-state machines. This thesis shows that networks based on Leiserson's fat-tree architecture are nearly as good as any network built in a comparable amount of physical space. It shows that these universal networks can efficiently simulate competing networks by means of an appropriate correspondence between network components and efficient algorithms for routing messages on the universal network. In particular, a universal network of area A can simulate competing networks with O(lg cubed A) slowdown (in bit-times), using a very simple randomized routing algorithm and simple network components. Alternatively, a packet routing scheme of Leighton, Maggs, and Rao can be used in conjunction with more sophisticated switching components to achieve O(lg squared A) slowdown. GRA

N90-18186# Massachusetts Inst. of Tech., Cambridge. Dept. of Electrical Engineering and Computer Science.
THEORETICAL AND EXPERIMENTAL ANALYSES OF PARALLEL COMBINATORIAL ALGORITHMS Ph.D. Thesis
Cynthia A. Phillips Oct. 1989 157 p Sponsored in part by IBM
(Contracts N00014-87-K-0825; N00014-86-K-0593)
(AD-A216407; MIT/LCS/TR-462) Avail: NTIS HC A08/MF A01 CSCL 12/1

This thesis investigates parallel algorithms for a small, but representative, subclass of graph and matrix problems. In some cases, we develop new algorithms which we analyze for theoretical efficiency. In other cases, we modify and implement existing algorithms which we analyze for practical efficiency. We show how n-node, e-edge graphs can be contracted in a manner similar to the parallel tree contraction algorithm due to Miller and Reif. We give an O((n+e)/lgn)-processor deterministic algorithm that contracts a graph in O(lg squared n) time in the EREW PRAM model. GRA

63 CYBERNETICS

Includes feedback and control theory, artificial intelligence, robotics and expert systems.

For related information see also *54 Man/System Technology and Life Support.*

N90-18187# Connecticut Univ., Storrs.
STOCHASTIC ADAPTIVE CONTROL AND ESTIMATION ENHANCEMENT Annual Report, 1 Aug. 1988 - 31 Jul. 1989
Y. Bar-Shalom 1 Sep. 1989 52 p LIMITED REPRODUCTIBILITY: Availability: Document partially illegible
(Grant AF-AFOSR-0202-88; AF Proj. 2304)
(AD-A215486; AFOSR-89-1572TR) Avail: NTIS HC A04/MF A01 CSCL 12/3

The investigations summarized in this report deal with: (1) adaptive dual control of systems with unknown parameters; (2) estimation and control of hybrid stochastic systems; (3) distributed estimation in systems with measurements of uncertain origin; and (4) solution of continuous-time hybrid stochastic differential equations. GRA

N90-18188# Institute for Defense Analyses, Alexandria, VA.
HIGH-LEVEL VISION AND PLANNING WORKSHOP PROCEEDINGS Final Report
Michael I. Bloom, ed. Aug. 1989 256 p Workshop held in Rehovot, Israel, 25 Apr. 1988; sponsored by DARPA, US-Israel Binational Science Foundation and Institute for Defense Analyses
(Contract MDA903-89-C-0003)
(AD-A215982; AD-E501178; IDA-D-649; IDA/HQ-89-034738)
Avail: NTIS HC A12/MF A01 CSCL 12/9

The slides, papers, and graphic illustrations presented at the joint U.S.-Israeli workshop on artificial intelligence are provided in this Institute for Defense Analyses document. This document is based on a broad exchange of ideas about current approaches and research issues in the areas of design automation and autonomous robotic systems. A list of participants is provided along with applicable references for individual papers. GRA

N90-18189# Air Force Wright Research and Development Center, Wright-Patterson AFB, OH. Electronics Warfare Div.
EVENT-TRAIN RESTORATION VIA BACKPROPAGATION NEURAL NETWORKS Interim Report, Jan. - Jul. 1989
Peter G. Raeth Dec. 1989 39 p
(AF Proj. 7633)
(AD-A216308; WRDC-TR-89-1149) Avail: NTIS HC A03/MF A01 CSCL 12/9

This project is investigating backpropagation neural networks for specific applications in passive electronic warfare involving restoration of deinterleaved event trains to their original broadcast form. This is different from traditional bit-error detection/correction which relies on a prior knowledge of what the original bit stream looked liked. In electronic warfare it is unlikely that such prior knowledge will be available. Results of this research can be applied to 3 major problem areas: (1) pulse-train restoration, (2) communications signal compression, and (3) data compression. GRA

N90-18190# Massachusetts Inst. of Tech., Cambridge. Lab. for Computer Science.
THE STRENGTH OF WEAK LEARNABILITY
Robert E. Schapire 16 Oct. 1989 37 p Sponsored in part by Siemens Corp.
(Contracts N00014-89-J-1988; DAAL03-86-K-0171)
(AD-A216389; MIT/LCS/TM-415) Avail: NTIS HC A03/MF A01 CSCL 05/8

The problem considered is that of improving the accuracy of an hypothesis output by a learning algorithm in the distribution-free (PAC) learning model. A concept class is learnable (or strongly learnable) if, given access to a source of examples from the unknown concept, the learner with high probability is able to output an hypothesis that is correct on all but an arbitrarily small fraction of the instances. The concept class is weakly learnable if the learner can produce an hypothesis that performs only slightly better

than random guessing. In this paper, it is shown that these two notions of learnability are equivalent. A method is described for converting a weak learning algorithm into one that achieves arbitrarily high accuracy. This construction may have practical applications as a tool for efficiently converting a mediocre learning algorithm into one that performs extremely well. In addition, the construction has some interesting theoretical consequences, including a set of general upper bounds on the complexity of any strong learning algorithm as a function of the allowed error. GRA

N90-18191# Army Inst. for Research in Management Information and Computer Sciences, Atlanta, GA.
EXPERT SYSTEMS DEVELOPMENT METHODOLOGY
J. W. Gowens 28 Jul. 1989 171 p
(AD-A216892; ASQBG-A-89-033) Avail: NTIS HC A08/MF A01 CSCL 12/9

The purpose of this guide is to provide the procedures to develop expert systems (ES) that can be used locally to assist in mission accomplishment and to aid decision processes of the local command. Using the guidelines in this document, applications can be screened for expert system attributes, potential projects evaluated and initial estimates of the project made. GRA

N90-18192# Army Inst. for Research in Management Information and Computer Sciences, Atlanta, GA.
TECHNOLOGY ASSESSMENT OF OPERATING SYSTEMS
Joseph Nealon 13 Feb. 1989 15 p
(AD-A216893; ASQBG-I-89-023) Avail: NTIS HC A03/MF A01 CSCL 12/5

With the introduction of the Intel 80386 microprocessor (a 32 bit processor as compared to the 8 and 16 bit processors of the past), the scope and capabilities associated with microcomputers has changed dramatically. The 80386 allows for multitasking and a virtual mode, making it possible for a micro to function as though it were several micros of the previous generation. However, in order to fully realize the potential of this hardware, the software which runs on it must be specifically designed to take advantage of the services provided. The four major operating systems for microcomputers on the market today are MS-DOS, Macintosh, OS/2, and UNIX. GRA

64 NUMERICAL ANALYSIS

Includes iteration, difference equations, and numerical approximation.

N90-18193*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
BOUNDARY ESTIMATION PROBLEMS ARISING IN THERMAL TOMOGRAPHY Final Report
H. T. Banks (University of Southern California, Los Angeles.), Fumio Kojima, and W. P. Winfree Nov. 1989 43 p Submitted for publication Prepared in cooperation with Institute for Computer Applications in Science and Engineering, Hampton, VA
(Contracts NAS1-18605; F49620-86-C-0111; NSF DMS-88-18530)
(NASA-CR-181964; NAS 1.26:181964; ICASE-89-44) Avail: NTIS HC A03/MF A01 CSCL 12A

Problems on the identification of two-dimensional spatial domains arising in the detection and characterization of structural flaws in materials are considered. For a thermal diffusion system with external boundary input, observations of the temperature on the surface are used in a output least squares approach. Parameter estimation techniques based on the method of mappings are discussed and approximation schemes are developed based on a finite element Galerkin approach. Theoretical convergence results for computational techniques are given and the results are applied to experimental data for the identification of flaws in the thermal testing of materials. Author

N90-18194# Ballistic Research Labs., Aberdeen Proving Ground, MD. System Engineering and Concepts Analysis Div.
FIXED POINTS OF EXPANSIVE ANALYTIC MAPS
Walter O. Egerland and Charles E. Hansen Nov. 1989 13 p
(AD-A214356; BRL-TR-3063) Avail: NTIS HC A03/MF A01 CSCL 12/1

It is well known that non-expansive maps of a closed disk have a fixed point. Expansive maps of a closed disk need not have point. It is shown that an analytic quadratic and expansive map of a closed disk K always has a fixed point in K. GRA

N90-18195*# Institute for Computer Applications in Science and Engineering, Hampton, VA.
FACTORING SYMMETRIC INDEFINITE MATRICES ON HIGH-PERFORMANCE ARCHITECTURES Final Report
Mark T. Jones and Merrell L. Patrick (Duke Univ., Durham, NC.) Jan. 1990 16 p
(Contracts NAS1-18107; NAS1-18605; NAG1-466; AF-AFOSR-0117-88)
(NASA-CR-181982; ICASE-90-8; NAS 1.26:181982) Avail: NTIS HC A03/MF A01 CSCL 12A

The Bunch-Kaufman algorithm is the method of choice for factoring symmetric indefinite matrices in many applications. However, the Bunch-Kaufman algorithm does not take advantage of high-performance architectures such as the Cray Y-MP. Three new algorithms, based on Bunch-Kaufman factorization, that take advantage of such architectures are described. Results from an implementation of the third algorithm are presented. Author

N90-18196# George Mason Univ., Fairfax, VA. Dept. of Operations Research and Applied Statistics.
AN ALGORITHM FOR FINDING CHARACTERISTIC ROOTS OF QUASI-TRIANGULAR MARKOV CHAINS
Carl M. Harris, William G. Marchal, and Richard W. Tibbs 10 Nov. 1989 31 p
(Contract N00014-86-K-0029)
(AD-A215490; GMU/22474/111) Avail: NTIS HC A03/MF A01 CSCL 12/3

Numerical root finding problems are quite common in stochastic modeling. However, many solutions stop at the presentation of a probability generating function for the state probabilities. But with increasing easy access to computing power, many problems whose answers were typically left in incomplete form or for which there has been a search for alternative solution methods are currently being reexamined. The class of Markov chains whose transition matrices have quasi-triangular layouts (i.e., those having sub- or super-triangular sets of zeros) is a good case in point. They have an especially nice structure which leads to a rather concise representation for the generating functions. But the complete solution then requires the finding of roots. Fortunately, these problems can be shown to have special properties that make accurate root finding quite feasible, and an efficient numerical procedure for solution is supplied. GRA

N90-18197*# Old Dominion Univ., Norfolk, VA. Dept. of Mathematics and Statistics.
ESTIMATION IN A DISCRETE TAIL RATE FAMILY OF RECAPTURE SAMPLING MODELS Final Report, period ending 28 Feb. 1990
Rajan Gupta and Larry D. Lee Feb. 1990 14 p
(Grant NAG1-835)
(NASA-CR-180452; NAS 1.26:180452) Avail: NTIS HC A03/MF A01 CSCL 12A

In the context of recapture sampling design for debugging experiments the problem of estimating the error or hitting rate of the faults remaining in a system is considered. Moment estimators are derived for a family of models in which the rate parameters are assumed proportional to the tail probabilities of a discrete distribution on the positive integers. The estimators are shown to be asymptotically normal and fully efficient. Their fixed sample properties are compared, through simulation, with those of the conditional maximum likelihood estimators. Author

N90-18198*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
CONDITIONS AT THE DOWNSTREAM BOUNDARY FOR SIMULATIONS OF VISCOUS INCOMPRESSIBLE FLOW
Thomas Hagstrom (State Univ. of New York, Stony Brook.) Feb. 1990 26 p
(NASA Order C-99066-G)
(NASA-TM-102510; ICOMP-90-05; E-5312; NAS 1.15:102510)
Avail: NTIS HC A03/MF A01 CSCL 12A

The proper specification of boundary conditions at artificial boundaries for the simulation of time-dependent fluid flows has long been a matter of controversy. A general theory of asymptotic boundary conditions for dissipative waves is applied to the design of simple, accurate conditions at downstream boundary for incompressible flows. For Reynolds numbers far enough below the critical value for linear stability, a scaling is introduced which greatly simplifies the construction of the asymptotic conditions. Numerical experiments with the nonlinear dynamics of vortical disturbances to plane Poiseuille flow are presented which illustrate the accuracy of our approach. The consequences of directly applying the scalings to the equations are also considered.
Author

N90-18199# Lawrence Livermore National Lab., CA.
A PARALLEL ITERATIVE METHOD FOR SOLVING 3-DIMENSIONAL ELLIPTIC PARTIAL DIFFERENTIAL EQUATIONS
Anne Greenbaum, Edna Reiter, and Garry Rodrigue (California Univ., Davis.) 1989 11 p Presented at the North Atlantic Treaty Organization Supercomputer Workshop, Trondhein, Norway, 19-23 Jun. 1989 Submitted for publication
(Contracts W-7405-eng-48; DE-AC02-76ER-03077)
(DE90-005187; UCRL-102220; CONF-8906268-1) Avail: NTIS HC A03/MF A01

The parallel solution is considered of the Dirichlet problem for a second-order uniformly elliptic equation in two and three dimensions. Specifically, the problem considered is, L(u) = f in Omega, u = g on Gamma. For sake of exposition, it is assumed that the equation is 2-D, however, the extension to 3-D of the numerical methods to be described will be obvious. DOE

N90-18200# Stanford Univ., CA. Systems Optimization Lab.
ON MEAN VALUE ITERATIONS WITH APPLICATION TO VARIATIONAL INEQUALITY PROBLEMS
Jen-Chih Yao Dec. 1989 8 p
(Contracts DE-FG03-87ER-25028; N00014-89-J-1659; NSF DMS-89-13089)
(DE90-005556; SU-SOL-89-18) Avail: NTIS HC A03/MF A01

It is shown that in a Hilbert space, a mean value iterative process generated by a continuous quasi-nonexpansive mapping always converges to a fixed point of the mapping without any precondition. This result was then employed to obtain approximating solutions to the variational inequality and the generalized complementarity problems. DOE

N90-18201# International Centre for Theoretical Physics, Trieste (Italy).
NEW SPACETIME SUPERALGEBRAS AND THEIR KAC-MOODY EXTENSION
Eric Bergshoeff (European Organization for Nuclear Research, Geneva, Switzerland) and Ergin Sezgin Jul. 1989 13 p
(DE90-606949; IC-89/126) Avail: NTIS (US Sales Only) HC A03/MF A01

New spacetime algebras are presented, whose existence is due to special Gamma-matrix identities which are also necessary for the existence of super p-branes. They contain a p-th rank antisymmetric tensor, and a (p-1) rank antisymmetric tensor-spinor generator. Furthermore the translations do not commute with the supercharge. In the case of supermembranes, a super-Kac-Moody extension of the new spacetime algebra was found. A realization is given of the algebra in terms of operators in d=11 superspace, and a connection was found with the d=11 supermembrane action which leads to an elegant supergeometric formulation. By double dimensional reduction, a Kac-Moody algebra was obtained for the Type IIA Green-Schwarz superstring. The generalization of these results is discussed, including the construction of generalized super-Virasoro algebras, for super p-branes. DOE

N90-18202# International Centre for Theoretical Physics, Trieste (Italy).
ITERATIVE METHODS FOR NONLINEAR SET-VALUED OPERATORS OF THE MONOTONE TYPE WITH APPLICATIONS TO OPERATOR EQUATIONS
C. E. Chidume Jun. 1989 14 p
(DE90-606950; IC-89/130) Avail: NTIS (US Sales Only) HC A03/MF A01

The fixed points of set-valued operators satisfying a condition of monotonicity type in real Banach spaces with uniformly convex dual spaces are approximated by recursive averaging processes. Applications to important classes of linear and nonlinear operator equations are also presented. DOE

N90-18203# International Centre for Theoretical Physics, Trieste (Italy).
INDUCTION ON A CONTINUOUS VARIABLE
Jingzhong Zhang Jun. 1989 8 p Submitted for publication
(DE90-606952; IC-89/157) Avail: NTIS (US Sales Only) HC A02/MF A01

Mathematical induction is a useful tool. But it could be used to prove only the proposition with form P(n) for the natural number n. Could the natural number n be replaced by a continuous variable x. Yes, and then the continuous induction is obtained. The continuous induction is very easy to grasp by the students who have learned mathematical induction. And it can be used to prove many basic propositions in the elementary calculus. DOE

N90-18204# International Centre for Theoretical Physics, Trieste (Italy).
SELF SIMILAR SOLUTIONS OF THE SECOND KIND OF NONLINEAR DIFFUSION-TYPE EQUATIONS
Javier Albert Diez, Julio Gratton, and Fernando Minotti (Buenos Aires Univ., Argentina) Jul. 1989 17 p Submitted for publication
(DE90-606953; IC-89/171) Avail: NTIS (US Sales Only) HC A03/MF A01

The self similar solutions are studied for the problem of one-dimensional nonlinear diffusion of a passive scalar u (diffusivity D similar to u(sup m), m is greater than or equal to 1) towards the center of a cylindrical or spherical symmetry. It is shown that this problem has a self similar solution of the second kind. The self similarity exponent delta is found by solving a nonlinear eigenvalue problem arising from the requirement that the integral curve that represents the solution must join the appropriate singular points in the phase plane of the diffusion equation. In this way the integral curves that describe the solution before, and after the diffusive current arrives at the center of symmetry can be determined. The eigenvalues for different values of the nonlinearity index m and for cylindrical and spherical geometry are computed. Numerical integration of the equations allows the determination of the shape of the solution in terms of the physical variables. The application to the case m=3, corresponding (for cylindrical symmetry) to the creeping gravity currents of a very viscous liquid is worked out in detail. DOE

N90-18205# International Centre for Theoretical Physics, Trieste (Italy).
ON PURE RADICAL IN SEMIGROUPS WITH ZERO
J. Ahsan and A. B. Thaheem Jul. 1989 6 p Submitted for publication
(DE90-606954; IC-89/177) Avail: NTIS (US Sales Only) HC A02/MF A01

The pure radical of an ideal is introduced in a semigroup with zero. For this purpose pure, semipure, and other related types of ideals are introduced and some of their basic properties established. DOE

N90-18206# International Centre for Theoretical Physics, Trieste (Italy).
NOTE ON p-SEMISIMPLE BCI-ALGEBRAS
M. Aslam (Rawalpindi Government Coll. of Technology, Pakistan) and A. B. Thaheem Jul. 1989 8 p Submitted for publication
(DE90-606955; IC-89/183) Avail: NTIS (US Sales Only) HC A02/MF A01

In this note some equivalent conditions are proved for p-semisimple BCI-algebras. It is also shown that if X is a p-semisimple BCI-algebra then Hom(X), the set of all homomorphisms of X is a (p-semisimple) BCI-algebra, thus extending the class of BCI-algebras with this property as proposed. Some duality conditions were also studied. DOE

N90-18207# International Centre for Theoretical Physics, Trieste (Italy).
MINIMAL PRIME IDEALS IN SEMIGROUPS WITHOUT NILPOTENT ELEMENTS
J. Ahsan Jul. 1989 8 p Submitted for publication
(DE90-606957; IC-89/195) Avail: NTIS (US Sales Only) HC A02/MF A01

A characterization is presented of minimal prime ideals of (non-commutative) semigroups without nilpotent elements analogous to the one for the corresponding class of rings. The notion of symmetric ideals of a semigroup were also defined and some of their basic properties were established. DOE

N90-18208# International Centre for Theoretical Physics, Trieste (Italy).
CONSTRUCTION OF SECOND CONSTANT OF MOTION FOR TWO DIMENSIONAL CLASSICAL SUPER SYSTEMS
S. C. Mishra and Veena Mishra (Delhi Univ., India) May 1989 13 p Submitted for publication
(DE90-607046; IC-89/80) Avail: NTIS (US Sales Only) HC A03/MF A01

The construction of the second constant of motion of second order (for N greater than or equal to 2 super-space) is carried out using Dirac's constrained Hamiltonian formalism. The invariants involving quadratic powers in velocities for a set of four representative potentials, namely: (1) super harmonic oscillator; (2) super Kepler potentials; (3) the super potential (lambda)q(sup 2/3) and (4) the super potential (lambda)q(sup 2)/1+gq(sup 2) were derived. DOE

N90-18209# National Environmental Satellite Service, Washington, DC.
A GENERAL METHOD OF USING PRIOR INFORMATION IN A SIMULTANEOUS EQUATION SYSTEM
Lawrence J. Crone, David S. Crosby (American Univ., Washington, DC.), and Larry M. McMillin Oct. 1989 26 p
(NOAA-TR-NESDIS-47) Avail: NTIS HC A03/MF A01

A method of using prior information in the estimation of the parameters in a simultaneous-equation-like model is presented. The technique, which is called rotated regression, consists of the following steps: (1) the data are transformed into a new coordinate system where the prior estimate has a simple form; (2) a regression procedure is carried out in the new coordinate system to modify the prior estimate; and (3) the data are then transformed back into the original coordinate system. A general method for using the technique is developed. The necessary mathematical theory is presented. It is shown that orthogonal regression has a simple relationship to rotated regression. An example using satellite measured radiances shows that the technique works very well for certain types of data. Author

N90-18210# Maryland Univ., College Park. Inst. for Physical Science and Technology.
ON THE EXPONENTIAL CONVERGENCE OF THE h-p VERSION FOR BOUNDARY ELEMENT GALERKIN METHODS ON POLYGONS Final Report
I. Babuska, B. Q. Guo, and E. P. Stephan (Georgia Inst. of Tech., Atlanta.) May 1989 23 p
(Contract N00014-85-K-0169; NSF DMS-85-16191; NSF DMS-87-04483)
(AD-A215814; BN-1099) Avail: NTIS HC A03/MF A01 CSCL 12/1

This paper applies the technique of the h-p version to the boundary element method for boundary value problems on nonsmooth, plane domains with piecewise analytic boundary and data. The exponential rate of convergence of the boundary element Galerkin solution is proven when a geometric mesh refinement towards the vertices is used. GRA

N90-18211# Maryland Univ., College Park. Inst. for Physical Science and Technology.
THE h-p VERSION OF THE BOUNDARY ELEMENT METHOD WITH GEOMETRIC MESH ON POLYGONAL DOMAINS Final Report
I. Babuska, B. Q. Guo, and E. P. Stephan (Georgia Inst. of Tech., Atlanta.) May 1989 10 p
(Contract N00014-85-K-0169; NSF DMS-85-16191; NSF DMS-87-04463)
(AD-A215815; BN-1100) Avail: NTIS HC A02/MF A01 CSCL 12/2

The techniques of the h-p version are applied to the boundary element method for boundary value problems on plane non-smooth domains with piecewisely analytic boundary and data. The exponential rate of convergence of the boundary element Galerkin solution is obtained when a geometric mesh refinement is used near the vertices. GRA

N90-18212# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
A FRACTIONAL CALCULUS MODEL OF AEROELASTICITY M.S. Thesis
David V. Swinney Dec. 1989 60 p
(AD-A216244; AFIT/GA/ENY/89D-5) Avail: NTIS HC A04/MF A01 CSCL 20/4

This thesis introduces a new model of aeroelastic behavior. It simplifies the unsteady aerodynamic force expressions for a flat plate by employing fractional order time derivatives to create a compact fractional order polynomial model of Theodorsen's function. This model is used to reduce the system equations of motion to a single fractional derivative eigenvalue problem. The eigenvalue problem is solved at increasing airspeeds to produce a root locus plot of system stability using airspeed as a gain. This method is shown to yield accurate system instability speeds. GRA

N90-18213# Purdue Univ., West Lafayette, IN. Dept. of Statistics.
ON DETECTING INFLUENTIAL DATA AND SELECTING REGRESSION VARIABLES
Shanti S. Gupta and Deng-Yuan Huang (National Taiwan Normal Univ., Taipei.) Dec. 1989 19 p
(Contract N00014-88-K-0170; NSF DMS-86-06964; NSF DMS-87-02620)
(AD-A216387; TR-89-28C) Avail: NTIS HC A02/MF A01 CSCL 12/3

We consider a linear regression model. We attempt to measure the influence on the residual for the full model and the reduced model. A criterion to select important independent regression variables is also derived using the influence diagnostics. This criterion turns out to be the same as the one proposed by Gupta and Huang (1988). GRA

N90-18214# Edinburgh Univ. (Scotland).
PROCEEDINGS OF A RESEARCH WORKSHOP ON NONLINEAR TIME SERIES ANALYSIS AND APPLICATIONS Final Report
28 Sep. 1989 9 p Workshop held in Edinburgh, Scotland, 12-25 Jul. 1989
(Contract DAJA45-89-M-0211)
(AD-A216541; R/D-6219-MA-02) Avail: NTIS HC A02/MF A01 CSCL 12/1

The purpose of the workshop was to explore the current state

of research and applications in nonlinear time series analysis and to explore the common ground between the statistical and mathematical dynamical approach to nonlinear temporal systems. Attention was given to the practical use of theoretical developments in this topic. The Workshop had three main aspects -- Probabilistic aspects, Statistical aspects, and Dynamical systems. GRA

65 STATISTICS AND PROBABILITY

Includes data sampling and smoothing; Monte Carlo method; and stochastic processes.

N90-18215# Massachusetts Univ., Amherst. Human Performance Lab.
IMPACT OF UNCERTAINTY AND DIAGNOSTICITY ON CLASSIFICATION OF MULTIDIMENSIONAL DATA WITH INTEGRAL AND SEPARABLE DISPLAYS OF SYSTEM STATUS
Bruce G. Coury, Margery D. Boulette, and Robert A. Smith 1989 52 p Submitted for publication
(Contract DAAA15-85-K-0010)
(AD-A215966; TR-BGC1-1989) Avail: NTIS HC A04/MF A01 CSCL 12/6

Integrative, object-like displays have been advocated for presenting multi-dimensional system data. In this research, two experiments assessed the relative merits of integral and separable displays to enhance information processing ability when the identity of an instance of system data is uncertain. In each experiment, thirty subjects, equally divided into three groups, were trained to classify instances of system state into one of four state categories using a Configural display, a Bargraph display, or a Digital display. In Experiment 1, the distribution of instances from the range of possibilities within a state category were uniform; in Experiment 2, the distribution was biased toward those instances of highly uncertain state category membership. After training, subjects received extended practice classifying instances. In both experiments, uncertainty was found to have the greatest impact on the time to classify an instance of system data. In Experiment 1, the Bargraph display was consistently superior under all conditions of uncertainty. The Configural display was found to be superior to the Digital display under conditions of low uncertainty, while the Digital display was superior to the Configural display under conditions of high uncertainty. In Experiment 2, the superiority of the Bargraph display diminished, producing results equivalent to those of the Digital display; performance with the Configural display was worse than either of the other two displays. GRA

N90-18216# Stanford Univ., CA. Dept. of Statistics.
A SAMPLE REUSE METHOD FOR ACCURATE PARAMETRIC EMPIRICAL BAYES CONFIDENCE INTERVALS
Bradley P. Carlin and Alan E. Gelfand 7 Nov. 1989 25 p
(Contract N00014-89-J-1627)
(AD-A216198; TR-423) Avail: NTIS HC A02/MF A01 CSCL 12/2

Parametric empirical Bayes methods of point estimation for a vector of unknown parameters date to the landmark paper of James and Stein (1961). The usual approach is to use the mean of the estimated posterior distribution of each parameter, where the estimation of the prior parameters (hyperparameters) is accomplished through the marginal distribution of the data. While point estimates computed this way usually perform well, interval estimates based on the estimated posterior (called naive EB intervals) are not. They fail to account for the variability in the estimation of the hyperparameters, generally resulting in sub-nominal coverage probability in the EB sense defined in Morris (1983a). In this paper we extend the work of Carlin and Gelfand (1989), who proposed a conditional bias correction method for developing EB intervals which corrects the deficiencies in the naive intervals. We show how bias correction can be implemented in general via a Type III parametric bootstrap procedure, a sample reuse method first employed by Laird and Louis (1987). GRA

66 SYSTEMS ANALYSIS

Includes mathematical modeling; network analysis; and operations research.

N90-18217# RAND Corp., Santa Monica, CA.
USER'S GUIDE TO OPUS (OPTIMAL PREFERENTIAL UTILITY AND STRATEGIES) Interim Report
Zachary F. Lansdowne Aug. 1989 92 p
(Contract F49620-86-C-0008)
(AD-A214384; RAND-N-2903-AF) Avail: NTIS HC A05/MF A01 CSCL 12/5

A user's guide is presented to the latest version of the OPUS (Optimal Preferential Utility and Strategies) program. When a set of targets is attacked by reentry vehicles (RVs) and defended by interceptors, this program evaluates the effectiveness of a defense employing preallocated preferential strategies. A stochastic model of terminal defense is used to represent up to two layers of interceptors. The targets can be divided into multiple categories, with different parameter values for each category. The RVs can arrive either sequentially or simultaneously, and they can be accompanied by up to two types of decoys. The defense can employ uniform tapered, or salvo firing doctrines; and they can use deception with respect to the locations of both interceptors and targets. The optimal offensive and defensive strategies are determined by solving a two person zero-sum constrained game. GRA

N90-18218# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
STRUCTURED ANALYSIS TOOL INTERFACE TO THE STRATEGIC DEFENSE INITIATIVE ARCHITECTURE DATAFLOW MODELING TECHNIQUE M.S. Thesis
Kenneth Albert Austin Dec. 1989 113 p
(AD-A216281; AFIT/GCS/ENG/89D-1) Avail: NTIS HC A06/MF A01 CSCL 15/3

A software interface was designed and implemented that extends the use of Structured Analysis (SA) Tool (SAtool) as a graphical front-end to the Strategic Defense Initiative Architecture Dataflow Modeling Technique (SADMT). SAtool is a computer-aided software engineering tool developed at the Air Force Institute of Technology that automates the requirements analysis phase of software development using a graphics editor. The tool automates two approaches for documenting software requirements analysis: SA diagrams and data dictionaries. SADMT is an Ada based simulation framework that enables users to model real-world architectures for simulation purposes. This research was accomplished in three phases. During the first phase, entity-relationship (E-R) models of each software package were developed. From these E-R models, relationships between the two software packages were identified and used to develop a mapping from SAtool to SADMT. The next phase of the research was the development of a software interface in Ada based on the mapping developed in the first phase. A combination of a top-down and a bottom-up approach was used in developing the software. GRA

67 THEORETICAL MATHEMATICS

Includes topology and number theory.

N90-18219# Stanford Univ., CA. Systems Optimization Lab.
FIXED POINTS BY ISHIKAWA ITERATIONS
Jen-Chih Yao Dec. 1989 6 p
(Contracts DE-FG03-87ER-25028; N00014-89-J-1659; NSF DMS-89-13089)
(DE90-005557; SU-SOL-89-19) Avail: NTIS HC A02/MF A01

A class of mappings called generalized quasi-nonexpansive mappings in a Hilbert space is introduced. It is shown that a certain Ishikawa iterative process generated by a continuous generalized quasi-nonexpansive and monotone mapping on a

compact and convex subset of a Hilbert space always converges strongly to a fixed point of the mapping without any precondition. DOE

N90-18220# International Centre for Theoretical Physics, Trieste (Italy).
CUBIC INTERACTION IN CONFORMAL THEORY OF INTEGER HIGHER-SPIN FIELDS IN FOUR DIMENSIONAL SPACE-TIME
E. S. Fradkin and V. Ya. Linetsky (Academy of Sciences, USSR, Moscow) Jul. 1989 21 p Submitted for publication
(DE90-607095; IC-89/173) Avail: NTIS (US Sales Only) HC A03/MF A01

Based on the infinite-dimensional algebra hsc(sup infinity) constructed by us, the cubic interaction in the conformal theory of higher-spin fields in four-dimensional space-time is obtained. The theory contains an infinite number of fields of all integer spins s greater than or equal to 2 and extends the conformal gravity. DOE

70 PHYSICS (GENERAL)

For precision time and time interval (PTTI) see *35 Instrumentation and Photography;* for geophysics, astrophysics or solar physics see *46 Geophysics, 90 Astrophysics,* or *92 Solar Physics.*

N90-18221# Los Alamos National Lab., NM.
NONLINEAR DYNAMICS OF DOMAIN WALLS AND VORTICES IN TWO-DIMENSIONAL SYSTEMS
A. R. Bishop 1989 14 p Presented at the 2nd Woodward Conference on Nonlinear Structures in Physical Systems, San Jose, CA, 17-18 Nov. 1989
(Contract W-7405-eng-36)
(DE90-004840; LA-UR-89-4104; CONF-8911159-1) Avail: NTIS HC A03/MF A01

We discuss analytic and numerical studies of experimentally accessible 2-dimensional condensed matter systems which support nonlinear domain wall and vortex structures. These systems include quasi-2-dimensional magnets and 2-dimensional arrays of Josephson junctions. We emphasize the importance of these systems for investigating: complex (frustrated) ground states, dynamics (including glassy dynamics), interactions between domain walls and vortices, and phase transitions at finite temperature accompanied by these excitations. DOE

N90-18222# Central Research Inst. of Electric Power Industry, Tokyo (Japan). Energy and Environment Lab.
MEASUREMENT OF RADIATION PROPERTY OF LONG INFRARED EMITTER AND EXAMINATION OF INFRARED RADIATION HEATING PROCESS
Y. Nakano, T. Miyanaga, and M. Miyakawa May 1989 40 p In JAPANESE; ENGLISH summary
(DE90-741971; CRIE-T-88102) Avail: NTIS (US Sales Only) HC A03/MF A01

Long infrared radiation is becoming widely used for process heating, drying and space heating. In order to make more effective use of long infrared radiation, the investigations on measuring method of radiation property of long infrared emitter, the measuring results, and selection of suitable emitters for heating objects, were carried out. Using Fourier transform infrared radiation spectrophotometer, trial manufacture of an apparatus for measuring spectral emissivity of long infrared emitters was conducted and the measuring method was established. By this, the following knowledges on ceramic long infrared emitter were obtained: spectral emissivity almost never depends on temperature of the emitter, variation with time is hardly shown, and radiation efficiency is shown to be 50 to 60 percent. Infrared radiation heating processes on foods and synthetic resins were investigated, and an examination on the method for selecting emitters, which are suitable to materials to be heated, was conducted. DOE

N90-18223# David Taylor Research Center, Bethesda, MD. Dept. of Propulsion and Auxiliary Systems.
MAGNETOHYDRODYNAMIC LIQUID-METAL FLOWS IN A RECTANGULAR CHANNEL WITH AN AXIAL MAGNETIC FIELD, A MOVING CONDUCTING WALL, AND FREE SURFACES Final Report
Gita Talmage, John S. Walker, Samuel H. Brown, Neal A. Sondergaard, and Patricia E. Burt (Naval Academy, Annapolis, MD.) Nov. 1989 79 p Sponsored by DNA
(AD-A216276; DTRC-89/019) Avail: NTIS HC A05/MF A01 CSCL 20/3

Fully developed, viscous liquid-metal velocity profiles and induced magnetic field contours were studied for Hartmann number of M=2 and 10 and for different load currents for a particular rectangular channel configuration (two-dimensional Couette flow). The rectangular channel was assumed to have a homogeneous external (axial) magnetic field parallel to the moving, perfectly conducting top wall and the stationary, perfectly conducting bottom wall. The two stationary side walls were also perfect conductors. The small gap between the moving wall and each side wall was an insulating, free surface. The method of weighted residuals was used to obtain truncated series solutions for the variables of interest. The heavy load currents across the channel were obtained by simulating an external potential to the conducting moving wall. The load currents in each case were opposed by the induced electric field. Since there is no pressure gradient, the flow along the channel is driven by the viscous effects of the moving wall and the Lorentz body force and is retarded by the stationary walls. The circulation is driven by the generator that is due to the axial variation of velocity in an axial magnetic field. The numerical data presented show that the radial gap and the free surface region represent electrical resistances in parallel between the perfectly conducting stationary wall and the perfectly conducting moving wall. GRA

N90-17899*# Oak Ridge National Lab., TN.
OPTICAL JOHNSON NOISE THERMOMETRY
R. L. Shepard, T. V. Blalock, L. C. Maxey, M. J. Roberts, and M. L. Simpson *In* JPL, Proceedings of the Second Noncontact Temperature Measurement Workshop 1 Jun. 1989 p 42-49 Previously announced as N89-20437 (For primary document see N90-17894 10-31)
(Contract DE-AC05-84OR-21400)
Avail: NTIS HC A16/MF A03 CSCL 20C

N90-17917*# Case Western Reserve Univ., Cleveland, OH. Dept. of Chemical Engineering.
ON THE TEMPERATURE OF SURFACES
J. Adin Mann, Jr. and Robert V. Edwards *In* JPL, Proceedings of the Second Noncontact Temperature Measurement Workshop 1 Jun. 1989 p 221-229 (For primary document see N90-17894 10-31)
Avail: NTIS HC A16/MF A03 CSCL 20C

71 ACOUSTICS

Includes sound generation, transmission and attenuation. For noise pollution see *45 Environmental Pollution.*

N90-18224# Central Research Inst. of Electric Power Industry, Tokyo (Japan).
STUDY OF ACTIVE NOISE CONTROL IN DUCTS
Yoshiatsu Nakao Aug. 1988 27 p In JAPANESE; ENGLISH summary
(DE89-772353; CRIE-T-87102) Avail: NTIS (US Sales Only) HC A03/MF A01

On an active control to reduce noise in ducts, the theoretical and experimental studies of the energy ratio of the noise and the cancelling sound which should be produced by a speaker, were carried out. In case the cancelling sound was produced by the speaker which was set in the branch duct, the energy ratio varied with the setting position, the length and the cross section of the

branch duct and the frequency of the noise. As the non-dimensional length of the branch duct was drawing near 0.5, the energy ratio became small. But when the non-dimensional length was 0, the ratio did not become smaller than 1. The experimental test confirmed that it was possible to reduce the noise by the cancelling sound in which energy ratio was as small as about one hundredth of the noise. In case the noise was the pure sound, and the wavelength was over one fourth of the duct diameter, it was possible to reduce the noise more than 40 dB. And in case the wavelength was one eighth the reduction quantity was about 20 dB. Therefore, in case the noise is the pure sound or close to the pure sound, it is possible to apply the active noise control. DOE

N90-18225# Stanford Univ., CA. Dept. of Mechanical Engineering.
DIRECT NUMERICAL SIMULATION OF AERODYNAMIC NOISE Annual Progress Report No. 1
Parviz Moin, Sanjiva K. Lele, and Tim Colonius 29 Sep. 1989 39 p
(Contract N00014-88-K-0592)
(AD-A214122) Avail: NTIS HC A03/MF A01 CSCL 20/1

Direct Numerical Simulation of Aerodynamic Noise is a part of an overall research program in compressible turbulence including the study of the physics of compressible turbulence, shock turbulence interactions, reacting flows with heat release, and aerodynamic sound generation in shear flows. The objective in aerodynamic sound generation is to use direct numerical simulations as a tool to study the noise generation processes directly, specifically answer the following questions: (1) Can one relate particular flow regions and events to the far field noise; (2) What regions are the dominant contributors to the far field noise; (3) What is the role played by pairing process in noise generation; (4) How important are the small scales to the noise generation; and (5) What processes control the far field directivity pattern. To answer these questions in shear flows, first study the acoustics of simple building block flows. The discussion below presents recent results obtained for one of the building block flows, the scattering of sound by a vortex. A short discussion of numerical accuracy is also given. Finally, results are presented for aerodynamic sound generation from a 2-D temporal mixing layer. GRA

N90-18226# Naval Ocean Systems Center, San Diego, CA. Analysis Branch.
NEUROBEAMFORMER 2: FURTHER EXPLORATION OF ADAPTIVE BEAMFORMING VIA NEURAL NETWORKS Final Report, Oct. 1987 - Sep. 1988
S. L. Speidel Jun. 1989 54 p Sponsored by Chief of Naval Research, Arlington, VA Original contains color illustrations
(AD-A215118; NOSC/TD-1606) Avail: NTIS HC A04/MF A01 CSCL 12/9

This paper discussed neural network technology as a tool for signal processing. Test results show that the adaptive beamformer method, based on neural network technology, performs the desired function of directing a beam so as to enhance a target signal and reject noise and interference. Comparing test output values with a matched-correlation output shows that the plotted crossbar circuit energy minima follow the shape of an inverted match-filter output. The neurobeamformer has certain advantages of implementation and adaptability over other methods. In concept, it is implementable in analog circuitry with no control code required. Thus a compact, simple, low-cost processor component that is not sensitive to array grooming can be produced. A straightforward adaptive beamformer cannot match the interference-cancellation performance of more exotic methods, which include sidelobe cancellers. So, a neuroprocessor, that will include a neurobeamformer as a component, will be built. This neuroprocessor will provide for cancellation of sidelobes, enhance source discrimination and angle-estimation through interaction of beams. Plans for this extended network were influenced by studies of the literature in biological sensory processing, both peripheral and central. GRA

N90-18227# Institut National des Sciences Appliquees, Lyon (France). Lab. Vibrations-Acoustiques.
ACOUSTIC RADIATION OF CYLINDRICAL SHELLS, WITH STIFFENING FINISHING AND COATED WITH MASKING MATERIALS Ph.D. Thesis [RAYONNEMENT ACOUSTIQUE DES COQUES CYLINDRIQUES, FINIES RAIDIES, REVETUES D'UN MATERIAU DE MASQUAGE]
Bernard Laulagnet 1989 195 p In FRENCH Sponsored in part by CNES, France
(Contracts DRET-85-065; DRET-87-242; CERDAN-58-848-902175; CERDAN-38948902-079)
(ISAL-89-0035; PES-85/1420/DRET/DS/SRS; ETN-90-96105)
Avail: NTIS HC A09/MF A02

An integral-modal computation procedure is used in order to obtain the vibration spectra of the stiffened shell from the original vacuum non-stiffened vibration modes. The study is useful to determine acoustic radiation from navigating ships. The masking coating is studied from the asymptotic development of the Navier-Stokes equation. The notion of dampened modes is introduced to illustrate typical phenomena found in immersed structures. ESA

N90-18228*# Texas A&M Univ., College Station. Dept. of Aerospace Engineering.
AN APPROXIMATE MODEL FOR THE PERFORMANCE AND ACOUSTIC PREDICTIONS OF COUNTERROTATING PROPELLER CONFIGURATIONS M.S. Thesis
Brett William Denner Dec. 1989 182 p
(Grant NAG3-354)
(NASA-CR-180667; NAS 1.26:180667) Avail: NTIS HC A09/MF A01 CSCL 20A

An approximate method was developed to analyze and predict the acoustics of a counterrotating propeller configuration. The method employs the analytical techniques of Lock and Theodorsen as described by Davidson to predict the steady performance of a counterrotating configuration. Then, a modification of the method of Lesieutre is used to predict the unsteady forces on the blades. Finally, the steady and unsteady loads are used in the numerical method of Succi to predict the unsteady acoustics of the propeller. The numerical results are compared with experimental acoustic measurements of a counterrotating propeller configuration by Gazzaniga operating under several combinations of advance ratio, blade pitch, and number of blades. In addition, a constant-speed commuter-class propeller configuration was designed with the Davidson method and the acoustics analyzed at three advance ratios. Noise levels and frequency spectra were calculated at a number of locations around the configuration. The directivity patterns of the harmonics in both the horizontal and vertical planes were examined, with the conclusion that the noise levels of the even harmonics are relatively independent of direction whereas the noise levels of the odd harmonics are extremely dependent on azimuthal direction in the horizontal plane. The equations of Succi are examined to explain this behavior. Author

N90-18229*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
UNSTEADY EULER ANALYSIS OF THE FLOW FIELD OF A PROPFAN AT AN ANGLE OF ATTACK
M. Nallasamy (Sverdrup Technology, Inc., Cleveland, OH.) and J. F. Groeneweg 1990 19 p Presented at the 28th Aerospace Sciences Meeting, Reno, NV, 8-11 Jan. 1990; sponsored by AIAA
(NASA-TM-102426; E-5191; NAS 1.15:102426; AIAA-90-0339)
Avail: NTIS HC A03/MF A01 CSCL 20A

The effects of angle of attack of a propfan on the blade loading and details of the flow field by solving the unsteady three-dimensional Euler equations are examined. The configuration considered is the SR7L propeller at cruise condition and the inflow angles considered are 4.6 degrees, 1.6 degrees and -0.4 degrees. The results indicate that the blade response is nearly sinusoidal at low inflow angles (1.6 degrees and -0.4 degrees) and significant deviations from sinusoidal behavior occur at an inflow angle of 4.6 degrees due to the presence of strong shocks on both suction and pressure surfaces of the blade. The detailed flow in the blade

passages shows that a shock formed on the suction surface during the highly loaded portion of the revolution extends across the passage to the pressure surface. An increase in inflow angle results in an increase in blade loading on the down-going side and a decrease in loading on the up-going side. Author

N90-18230# Air Force Occupational and Environmental Health Lab., Brooks AFB, TX.
MEASURING DAY-NIGHT NOISE LEVELS (DNL) USING THE METROSONICS db-310 SOUND LEVEL ANALYZER (DOSIMETER) Final Report, 1 Jul. - 12 Sep. 1989
Ali Y. Ali Sep. 1989 37 p
(AD-A215757; AFOEHL-89-103EI0111JNA) Avail: NTIS HC A03/MF A01 CSCL 20/1

The Metrosonics db-310 Dosimeter does not provide automatic calculation of DNLs for environmental noise surveys. Previous environmental noise surveys using the db-310 Dosimeter required DNL values to be calculated manually from the paper printout of sound levels. Manual calculations proved to be both laborious and monotonous; worse, one missed key stroke would require a restart of this whole calculation. In addition, the quality of the printouts are very poor if reproduction is required. The manual method of DNL calculating made long term environmental noise monitoring tedious and labor intensive with many opportunities for error. This report presents a program listing, setup requirements, procedures and operating instructions for DNL calculations using the Metrosonics db-310 Noise Dosimeter, a Z-248 or Z-184 Microcomputer, ENABLE software, and a BASIC program. Procedures and operating instructions describe: (1) programming the Metrosonics db-310 Dosimeter parameters for environmental noise measurements, (2) down loading its data to a Zenith Z-248 or Z-184 Computer using ENABLE, and (3) running a BASIC program which calculates the DNL and provides a hard copy of the results. GRA

N90-18231# Naval Ocean Systems Center, San Diego, CA.
OPTIMIZATION OF GAUSSIAN BEAM WIDTHS IN ACOUSTIC PROPAGATION Final Report
D. F. Gordon Oct. 1989 21 p
(AD-A215893; NOSC/TD-1678) Avail: NTIS HC A03/MF A01 CSCL 20/1

The use of Gaussian beams to compute wave propagation phenomena is a field of current interest and activity. Porter and Bucker (1987) supply an extensive list of references. More recent references can be found in Benites and Aki (1989). Gaussian beams can be traced as rays in range-dependent media providing not only propagation loss, but travel times, multipath structure, and frequency dependence. The well-known ray theory problems of caustics and shadow zones are treated automatically. A beam width minimization technique applied to a Gaussian beam model developed by Dr. H. P. Bucker, is outlined. Porter and Bucker (1987) gives the formulation upon which the techniques is built. A free parameter E is usually determined in a heuristic manner. Here, it is shown that the minimization of beam width assigns a precise value to E. Examples are given showing that the minimized beams give good propagation losses in some cases. A case also shown in the standard Gaussian beams give poor results and the minimized beams give even worse results. The problem appears to arise in beams that pass near boundaries. This problem will have to be corrected before a final judgment can be made on the validity of minimum-width beams. GRA

N90-18232# Duke Univ., Durham, NC. Dept. of Psychology.
ON CATEGORIZING SOUNDS Annual Report, 1 Oct. 1988 - 31 Sep. 1989
Gregory R. Lockhead 1 Dec. 1989 26 p
(Grant AF-AFOSR-0353-87; AF Proj. 2313)
(AD-A216417; AFOSR-89-1777TR) Avail: NTIS HC A03/MF A01 CSCL 05/8

Results of the past year are consistent with a model having two assumptions: Successive sounds are remembered as overly similar, and subjects attempt to correct for this by adjusting their response scales. This holds for unidimensional and multidimensional stimuli. In addition, when two dimensions are varied (loudness and pitch were examined here) but only one is judged, trial-to-trial variations of the other dimension interfere with performance. The magnitude of this interference is greater when the other, irrelevant dimensions varies by larger amounts. GRA

N90-18233*# Boeing Commercial Airplane Co., Seattle, WA. New Product Development Organization.
FLIGHT SURVEY OF THE 757 WING NOISE FIELD AND ITS EFFECTS ON LAMINAR BOUNDARY LAYER TRANSITION. VOLUME 3: EXTENDED DATA ANALYSIS
Mar. 1988 286 p
(Contract NAS1-15325)
(NASA-CR-178419; NAS 1.26:178419; D6-53196-3-Vol-3) Avail: NTIS HC A13/MF A02 CSCL 20A

A flight program was completed in June of 1985 using the Boeing 757 flight research aircraft with an NLF glove installed on the right wing just outboard of the engine. The objectives of this program were to measure noise levels on the wing and to investigate the effect of engine noise on the extent of laminar flow on the glove. Details of the flight test program and results are contained in Volume 1 of this document. Tabulations and plots of the measured data are contained in Volume 2. The present volume contains the results of additional engineering analysis of the data. The latter includes analysis of the measured noise data, a comparison of predicted and measured noise data, a boundary layer stability analysis of 21 flight data cases, and an analysis of the effect of noise on boundary layer transition. Author

72 ATOMIC AND MOLECULAR PHYSICS

Includes atomic structure, electron properties, and molecular spectra.

N90-18234# Tri-Univ. Meson Facility, Vancouver (British Columbia).
STABILITY OF HOLLOW BEAMS IN LONGITUDINAL PHASE SPACE
R. Baartman and S. Koscielniak Sep. 1989 5 p Presented at the International Conference on High Energy Accelerators, Tsukuba, Japan, 20-26 Aug. 1989
(DE90-004284; TRI-PP-89-78; CONF-890803-44) Avail: NTIS (US Sales Only) HC A01/MF A01

In synchrotrons, bunched beams which are hollow in longitudinal phase space are known to be unstable. This was also found to be true in simulations which include only the space charge force. Mode coupling theory does predict instability but gives thresholds which are much higher than those found from simulations. DOE

N90-18235# Oak Ridge National Lab., TN. Engineering Physics and Mathematics Div.
MAXWELLIAN CASCADE MODEL
R. L. Macklin Nov. 1989 24 p
(Contract DE-AC05-84OR-21400)
(DE90-004389; ORNL/TM-11372) Avail: NTIS HC A03/MF A01

A model for gamma ray cascade de-excitation of a nucleus derived from the Maxwellian energy distribution function but imposing energy conservation was investigated. Energy distributions and multiplicities and their averages were found over a range of nuclear temperatures and excitation energies appropriate to neutron capture. The model was compared to existing measurements for tantalum, a case where the level density was high and thus a good approximation to the model. DOE

N90-18236# Materials Research Labs., Ascot Vale (Australia). Explosives Div.
MOLECULAR DYNAMICS SIMULATION OF SEDIMENTATION USING THE MONOTONIC LAGRANGIAN GRID
R. A. J. Borg, D. A. Jones, and S. G. Lambrakos (Naval Research Lab., Washington, DC.) Jul. 1989 17 p

(AD-A215099; MRL-TR-89-30; DODA-AR-005-727) Avail: NTIS HC A02/MF A01 CSCL 08/10

The implementation of a new algorithm is described for tracking nearest-neighbors, the Monotonic Lagrangian Grid (MLG), in a recently developed Molecular Dynamics (MD) code used to study sedimentation phenomena. The MLG is a highly efficient algorithm for tracking particle positions which is based on the assignment of a set of indices to each particle in the system. These indices are ordered according to the relative positions of each of the particles, and are continuously updated as particles move around in space. Application of the MLG to the existing sedimentation code reduces the dependence of the CPU time on total particle number N from N-sq to N. This is the first application of MLG to this type of system. Areas of the code are identified in which implementation of more advanced aspects of the MLG algorithm would allow efficient vectorization of the code and result in additional reduction in CPU time. Other applications for MD codes at MRL based on the MLG are also described. GRA

N90-18237# Brown Univ., Providence, RI. Dept. of Chemistry.
INTERACTIONS OF MOLECULES WITH SURFACES Progress Report, 1 Feb. 1989 - 1 Jan. 1990
E. F. Greene Jan. 1990 4 p
(Contract DE-FG02-85ER-13441)
(DE90-005337; DOE/ER-13441/12; COO-4974-12) Avail: NTIS HC A01/MF A01

The progress made on four projects supported by DOE Grant FG02-85ER13441 in the period 1 February 1989 to 31 December 1989 is presented. A long term study of the rate of transfer of electrons between gas atoms and the surfaces of crystals, using the technique of surface ionization, reached a point where it could be submitted for publication. Measurement of the energy dependence of the yields of Na+, K+, and Cs+ ions formed when beams of the corresponding alkali atoms M hit a Si(111) surface and of Na+ for Na striking a Pt surface at a temperature T are those expected for equilibrium for thermal kinetic energies of the incident atoms. Energy transfer to surfaces was studied by measuring the temperature rises of thermocouple surfaces exposed to molecular beams. For example, a platinum surface initially at room temperature intercepts intense molecular beams of He, Ar, H2, N2, and SF6 emerging from a nozzle also at room temperature. He diffraction was used to follow structural phase transitions on the (111) and (100) surfaces of Si and Ge. The seventh-order peaks of the Si(111)-7 x 7 reconstructed surface observed at room temperature first decrease with increasing temperature and then disappear near 1140 K where there are also a sharp decrease in the specular intensity and an increase in the diffuse scattering. Work is in progress to measure the effect of adsorbed atoms on the forces parallel to the surface of a crystal as they are revealed by changes in the curvature of the surface. The first experiments are being done with alkali atoms adsorbed on a Si(111) surface. As others have shown, the opposite process of producing changes in the surface by bending the crystal can be observed. DOE

N90-18238# Arizona Univ., Tucson. Dept. of Chemistry.
CHEMICAL ACTIVATION OF MOLECULES BY METALS: EXPERIMENTAL STUDIES OF ELECTRON DISTRIBUTIONS AND BONDING Progress Report, 1 Oct. 1988 - 30 Nov. 1989
Dennis L. Lichtenberg 1989 20 p
(Contract DE-FG02-86ER-13501)
(DE90-005371; DOE/ER-13501/5) Avail: NTIS HC A03/MF A01

During this period some important breakthroughs were accomplished in understanding the relationships between molecular ionization energies and bond energies in transition metal complexes, in understanding the electronic factors of carbon-hydrogen bond activation by transition metals, in characterizing small molecule bonding interactions with transition metals, and in investigating intermolecular interactions in thin films of transition metal complexes. The formal relationship between measured molecular ionization energies and thermodynamic bond dissociation energies was developed into a single equation which unifies the treatment of covalent bonds, ionic bonds, and partially ionic bonds. The relationship was used to clarify the fundamental thermodynamic information relating to metal-hydrogen, metal-alkyl, and metal-metal bond energies. The ionization energies were also used to correlate the rates of carbonyl substitution reactions of (eta(sup 5)-C5H4X)Rh(CO)2 complexes, and to reveal the factors that control the stability of the transition state. The investigations of the fundamental interactions of C-H sigma and sigma* orbitals metals were continued with study of eta(sup 3)-1-methylallyl metal complexes. Direct observation and measurement of the stabilization energy provided by the agostic interaction of the C-H bond with the metal was obtained. The ability to observe the electronic effects of intermolecular interactions by comparing the ionizations of metal complexes in the gas phase with the ionizations of thin solid organometallic films prepared in ultra-high vacuum was established. Most significantly, the scanning tunneling microscope imaging of these thin films was accomplished. DOE

N90-18239# Brookhaven National Lab., Upton, NY. Physics Dept.
PHONON DISPERSION AND KOHN ANOMALIES IN THE ALLOY Cu(0.84)Al(0.16)
Henry Chou, S. M. Shapiro, S. C. Moss, and Mark Mostoller (Oak Ridge National Lab., TN.) 1989 6 p Presented at the Materials Research Society Fall Meeting, Boston, MA, 27 Nov. - 2 Dec. 1989 Submitted for publication
(Contracts DE-AC02-76CH-00016; DE-AC05-84OR-21400)
(DE90-005578; BNL-43657; CONF-891119-66) Avail: NTIS HC A02/MF A01

Detailed measurements were made of phonon frequencies along all high-symmetry directions on a large single crystal of Cu(0.84)Al(0.16) at room temperature. Phonon frequencies were ascertained to better than + or - 0.03 MeV. Inter-atomic force constants and vibrational density of states were calculated by performing a Born-von Karman analysis on the complete set of phonon dispersion curves. In contrast to the case of pure Cu, no evident Kohn anomaly (neither in the phonon dispersion itself nor in the derivatives) was observed near the expected wave vector q = 2k(sub F). The absence of Kohn anomalies in the present system could be due either to a smeared out Fermi surface or to the possibility that the electron-electron interaction which screens the inter-ionic potential is not the dominant interaction in the system; i.e., the existence of Kohn anomalies in these alloys may depend mainly on the details of the electron-phonon interaction. DOE

N90-18240# International Centre for Theoretical Physics, Trieste (Italy).
STATISTICAL MECHANICAL MODELS FOR LIQUID AND AMORPHOUS STRUCTURE IN COVALENTLY BONDED SYSTEMS
Z. Badirkhan, A. Ferrante (Scuola Internazionale Superiore di Studi Avanzati, Trieste, Italy), M. Rovere, and M. P. Tosi Jun. 1989 19 p Submitted for publication
(DE90-607233; IC-89/156) Avail: NTIS (US Sales Only) HC A03/MF A01

Considerable effort has been given for some years to developing models of interatomic forces aimed at accounting for bond directionality in liquid and amorphous state calculations. Models involving three-body potentials have been especially useful for computer simulation studies of liquid and amorphous states in elemental semiconductors and binary chalcogenides of group-4 elements, starting with the work of Stillinger and Weber on silicon. However, pair potential models that may still account for the main effects of angular dependences of the effective interatomic forces, though at a primitive level, are desirable from the viewpoint of liquid structure theory. Developments in this direction are briefly reviewed, with particular emphasis on bond particle models for the structure of liquid and amorphous germanium. We also discuss the relation between liquid structure in a bond particle model and crystallization accompanied by volume expansion, as observed in elemental and III-V polar semiconductors. DOE

N90-18241# Texas Univ., Austin. Center for Particle Theory.
RESEARCH PROGRAM IN ELEMENTARY PARTICLE THEORY

E. C. G. Sudarshan and Duane A. Dicus Aug. 1989 57 p
(Contract DE-FG05-85ER-40200)
(DE90-005600; DOE/ER-40200/188) Avail: NTIS HC A04/MF A01

The following topics are discussed: mathematical physics, strings and gauge theories; application of particle physics to astrophysics; high energy phenomenology; and quantum mechanics. DOE

N90-18242# Washington Univ., Seattle. Dept. of Physics.
ELEMENTARY PARTICLE PHYSICS: EXPERIMENTAL
Jere J. Lord, T. H. Burnett, and R. Jeffrey Wilkes 22 Sep. 1989 38 p
(Contract DE-AS06-88ER-40423)
(DE90-005973; DOE/ER-40423/13) Avail: NTIS HC A03/MF A01

A research program was performed in high energy experimental particle physics. Studies of high energy hadronic interactions and leptoproduction processes continue using several experimental techniques. Progress was made on the study of multiparticle production processes in nuclei. Ultra-high energy cosmic ray nucleus-nucleus interactions were investigated by the Japanese American Cosmic Emulsion Expedriment (JACEE) using balloon-borne emulsion chamber detectors. In the area of particle astrophysics, studies of cosmic ray nuclear interactions made possible the use of the world's most accurate determination of the comparison of the cosmic rays above 10(exp 13)eV. It is the only detector that can observe interaction vertices and identify particles at energies up to 10 to 15 eV. The observations are getting close to placing limits on the acceleration mechanisms postulated for pulsars in which the spin and magnetic moment axes are at different angles. In June, 1989 approval was given by NASA for our participation in the Space Station program. The SCINATT experiment will make use of emulsion chamber detectors, similar to the planned JACEE hybrid balloon flight detectors. These detector will permit precise determination of secondary particle charges, momenta and rapidities, and the accumulation of data will be at least a factor of 10 to 100 greater than in balloon experiments. Emulsion chamber techniques are also employed in an experiment using accelerator heavy ion beams at CERN and Brookhaven National Laboratory to investigate particle production processes in central collisions of nuclei in the energy range 15 to 200A GeV. The study of hadroproduction in lepton interactions is continuing with approval of another 8 months run for deep inelastic muon scattering experiment E665 at Fermilab. DOE

N90-18243# Naval Research Lab., Washington, DC. Dynamics of Solids Branch.
X RAY SPECTRA PRODUCED BY NaF IMPLOSIONS
G. Mehlman, D. A. Newman (Naval Research Lab., Washington, DC.), and P. G. Burkhalter 13 Nov. 1989 19 p
(AD-A215803; NRL-MR-6575) Avail: NTIS HC A03/MF A01 CSCL 20/8

Spatially-resolved x ray spectra were collected of imploding sodium plasmas using the Naval Research Laboratory Gamble 11 pulsed-power generator. A capillary-discharge was used as the source to inject sodium-fluoride plasmas for the fast Z-pinch implosion experiments. The plasma images recorded by curved-crystal spectrographs correspond to intense emission from a 3.5 cm long plasma column in the 4 cm interelectrode gap. Absolute emissivity values were obtained for the radiation emitted in the Na X and Na XI discrete transitions as well as for the total K-shell emission over the spectral range 800 to 1600 eV. Plasma parameters were determined from the measured spectral intensities compared to the ones predicted by plasma radiation theory. In regions near the nozzle, electron densities of several times 10 to the 21st power 3/cm and electron temperatures of 200 to 300 eV are generated. GRA

N90-18244# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
ELECTRONIC ENERGIES FOR NEON DIMER DICATION RADIATIVE CHARGE TRANSFER M.S. Thesis
Roger Alan Deemer Dec. 1989 66 p
(AD-A215817; AFIT/GEP/ENP/89D-1) Avail: NTIS HC A04/MF A01 CSCL 20/5

This research was conducted to find the shape of the potential energy surfaces for the Neon dimer dication, designated Ne2(+2), to include all symmetries which dissociate to two ground state Ne(+) ions or a ground state Ne atom and Ne(+2) ion. The motivation is to investigate whether there is a minimum in the upper level, the Ne(+2) and Ne level, located in such a way that populations of bound dimer molecules can be built up without dissociating or transitioning to the lower level other than by radiative charge transfer. It is also of interest to show that the ground state is dissociative, that is that its energy is monotonically decreasing with increasing nuclear separation. Calculations were completed using programs known as Gaussian-86, and Diatom. Diatom produced excellent results for the He2(+2)test case. Ne2(+2) calculations were not as accurate as He2(+2), but results did indicate that bound upper level states exist which can only undergo charge transfer radiatively. This research computed Neon dimer dication potential energies for nuclear separations from 0.9 to 20 a.u. of Ne2(+2) sigma, pi, and delta states. GRA

N90-17908*# Jet Propulsion Lab., California Inst. of Tech., Pasadena. Applied Sciences and Microgravity.
A POTENTIAL NUCLEAR MAGNETIC RESONANCE IMAGING APPROACH FOR NONCONTACT TEMPERATURE MEASUREMENT
Stanley L. Manatt *In its* Proceedings of the Second Noncontact Temperature Measurement Workshop 1 Jun. 1989 p 141-149
(For primary document see N90-17894 10-31)
Avail: NTIS HC A16/MF A03 CSCL 20H

73 NUCLEAR AND HIGH-ENERGY PHYSICS

Includes elementary and nuclear particles; and reactor theory.

For space radiation see *93 Space Radiation.*

N90-18245# Los Alamos National Lab., NM.
MODEL-REFERENCE ADAPTIVE CONTROL APPLIED TO LOADFOLLOWING OF A SPACE-NUCLEAR POWER SYSTEM
John D. Metzger, Mohamed S. El-Genk, and Alex G. Parlos 1989 8 p Presented at the 7th Symposium on Space Nuclear Power Systems, Albuquerque, NM, 7-11 Jan. 1990
(Contract W-7405-eng-36)
(DE89-014561; LA-UR-89-1982; CONF-900109-3) Avail: NTIS HC A02/MF A01

Nuclear power systems are presently being investigated an an alternative for both commercial and military space power systems because of their projected longevity of 7 to 10 years, their mass advantage over other space power sources at powers above approximately 25 kw(sub e), and their ability to operate without direct illumination from the sun. These space nuclear power systems are being designed to supply from tens of kilowatts to multimegawatts of power for continuous operation of seven years and more. Space nuclear power systems designs that meet these requirements will not be available for refueling or maintenance during their lifetime. To ensure that the space-nuclear power system will operate safely and will respond in a predictable and desired manner, the design of the system's controller must account for changes in the system parameters over its lifetime. Model reference adaptive control are applied to an increase in the power demand by the load. A model reference adaptive controller will force the actual space nuclear power system to follow the predictable and desired response of a reference model, despite changes in the actual system's operating parameters. Included are the model reference adaptive control algorithm, the description of the computer simulation of a space nuclear power system and the reference model, and results that demonstrate the application of model reference adaptive control to a change in the load power demand. The results can ensure the transient response of the

system despite differences between the design of the system and the as-built system as well as for variations in the systems parameters. Author

N90-18246# Air Force Weapons Lab., Kirtland AFB, NM.
EXPERIMENTAL INVESTIGATION OF RELATIONSHIP BETWEEN NONLINEAR FIELD ENERGY AND EMITTANCE GROWTH Final Report, Sep. 1987 - May 1989
D. Young, S. S. McCready, M. G. McHarg, and L. D. Brasure Nov. 1989 25 p
(AD-A215813; WL-TR-89-31) Avail: NTIS HC A03/MF A01 CSCL 20/7

Understanding the phenomena of emittance growth in space-charge-dominated particle beams is important to any application that requires a small final emittance. Many researchers have looked at the process of emittance growth under these conditions. Wangler, et al., uses the idea of nonlinear field energy to describe emittance growth. In brief, a beam with a nonuniform radial intensity distribution has a potential energy associated with this distribution. As the beam propagates through a solenoidal magnetic field, this potential energy is turned into transverse kinetic energy and manifests itself as emittance growth. The experimental results shows that there is a relationship between the initial intensity profile and the tune ratio to the emittance of charged particle beams in solenoidal focusing fields. The results also agree with the predicted beam intensity profile changes under focusing for peaked and flat beams. This experiment shows that an experiment to verify this theory by using two different beam intensity profiles is feasible. More experimentation in this area is recommended. GRA

74 OPTICS

Includes light phenomena; and optical devices.
For lasers see *36 Lasers and Masers.*

N90-18247# Naval Research Lab., Washington, DC. Optical Techniques Branch.
THE APPLICATION OF FIBER OPTIC TECHNOLOGY TO FLOWMETERS Final Report, Oct. 1987 - Oct. 1988
C. A. Wade and Anthony Dandridge 26 Oct. 1989 58 p
(AD-A214389; NRL-MR-6568) Avail: NTIS HC A04/MF A01 CSCL 14/2

A survey of flow measurement techniques was carried out to assess the potential of a flowmeter using fiber optic sensing technology. The Coriolis mass flow sensing technique was identified as being the most promising, and an optically-powered experimental version employing fiber optic sensors was constructed and tested. The experimental flowmeter exhibited encouraging performance and further development, by a manufacturer experienced in Coriolis flowmeter design, is recommended. GRA

N90-18248# Department of the Navy, Washington, DC.
FIBER OPTIC TRANSVERSAL FILTER/VARIABLE DELAY LINE Patent Application
William K. Burns, inventor (to Navy) 13 Sep. 1989 24 p
(AD-D014328; US-Patent-Appl-SN-406440) Avail: NTIS HC A03/MF A01 CSCL 09/5

An optical transversal filter comprises a plurality of optically power splitting devices, e.g., 3 x 3 single mode optical couplers, interspersed with fiber optical delay segments. In a n-column system the number of optical couplers in each column is given by the progression: 1, 3, 9...3(n-1st power) and only two different lengths of the fiberoptic delay segments are required. Fiber optic delay segments of the appropriate delays are connected to the three outputs of each of the couplers such that the fiber optic delay segments connected to the last column provide 3 to the nth power taps. The outputs can be combined on a single fiber and multiple inputs can be used. Variable weight output taps are provided by connecting each output to an optical intensity modulator or switch. GRA

N90-18249# California Univ., Davis. Dept. of Electrical Engineering and Computer Science.
OPTICAL SHARED MEMORY Final Technical Report, Mar. - Dec. 1988
Stephen T. Kowel, Norman Matloff, C. Eldering, T. Schubert, and M. Loving Sep. 1989 47 p
(Contract F30602-81-C-0193; AF Proj. 2529)
(AD-A215090; RADC-TR-89-136) Avail: NTIS HC A03/MF A01 CSCL 20/6

The objective of this effort was to investigate and evaluate OPTIMUL, an Optical Interconnect for Multiprocessor Systems, which could be used to interconnect a range of granularity of processors and memories for access to very large/knowledge bases (10 to 12 to 10 to 16 bytes). The final report details results of the architecture simulation, and discusses the operation of the system. The report also includes designs for an Optically Writeable Ram Cell (OWRC), a Differential Amplifier/Static Ram Cell (SRAM), and a Balanced Receiver. GRA

N90-18250# California Univ., Berkeley. Lawrence Berkeley Lab. Center for X-Ray Optics.
MULTILAYER OPTICAL ELEMENTS FOR GENERATION AND ANALYSIS OF CIRCULARLY POLARIZED X RAYS
J. B. Kortright and J. H. Underwood Aug. 1989 25 p Presented at the 7th Synchrotron Radiation Instrumentation (SRI) National Conference, Berkeley, CA, 6-10 Aug. 1989
(Contract DE-AC03-76SF-00098)
(DE90-006103; LBL-27786; CONF-890802-19) Avail: NTIS HC A03/MF A01

Calculations of the relative phase changes of sigma and pi electric field components on Bragg reflection from and transmission through multilayers are presented. Large relative phase changes can be calculated in certain cases, which may lead to utility of multilayers as quarter-wave plates for generation and analysis of circularly polarized soft x radiation. Similar behavior may be expected for perfect crystals in the hard x ray range. DOE

N90-18251# Massachusetts Inst. of Tech., Lexington. Lincoln Lab.
OPTICAL ANTI-ALIASING FILTERS
R. E. Knowlden, J. R. Leger, G. J. Swanson, and A. L. Kachelmyer 13 Sep. 1989 28 p
(Contract F19628-85-C-0002)
(AD-A215826; TR-853; ESD-TR-89-150) Avail: NTIS HC A03/MF A01 CSCL 09/5

In an electro-optical imager, a readout device (e.g., CCD or vidicon) samples an image discretely. Often the sampling spatial frequency is much less than the Nyquist rate for the system optics. Scene clutter at higher spatial frequencies than the readout passband is aliased into the band, giving excess clutter in the observed image. A number of designs of pupil plane phase-only spatial filters to reduce this excess clutter, while maintaining the system transmittance, are described. The designs include continuous and binary phase filters in rectangular and polar coordinates. Some of the designs give significant reduction in the out-of-band clutter. GRA

N90-18252# Naval Ocean Systems Center, San Diego, CA.
EFFECT OF MARINE ATMOSPHERE ON PERFORMANCE OF ELECTROOPTICAL SYSTEMS Final Report, 30 Sep. 1988 - 30 Sep. 1989
J. H. Richter, H. G. Hughes, and M. R. Paulson Aug. 1989 43 p
(AD-A215947; NOSC/TD-1635) Avail: NTIS HC A03/MF A01 CSCL 09/5

This report reviews the exploratory development effort in the U.S. Navy to provide an atmospheric effects assessment capability for existing and planned electrooptical (EO) systems. For many EO system applications, it is necessary to have an accurate knowledge of marine background radiances and to consider the effects of the intervening atmosphere. Accordingly, a capability was developed to estimate the apparent sea surface radiance for different sea states and meteorological conditions. Also, an

empirical relationship was developed which directly relates apparent mean sea temperature to calculated mean sky temperature. A careful investigation was conducted of lidar (light detection and ranging) techniques. It was concluded that single-ended, single-frequency lidars cannot be used to infer slant-path extinction with an accuracy necessary to make meaningful performance assessments. Other lidar configurations may find limited application in model validation and research efforts. No technique has emerged yet which could be considered ready for shipboard implementation. A shipboard real-time performance assessment system was developed and named PREOS (Performance and Range for EO Systems). PREOS has been incorporated into the Navy's Tactical Environmental Support System (TESS). The present version of PREOS is a first step in accomplishing the complex task or real-time systems performance assessment. GRA

N90-18253# Battelle Pacific Northwest Labs., Richland, WA.
DEVELOP TECHNIQUES FOR ION IMPLANTATION OF PLZT FOR ADAPTIVE OPTICS Final Report, Oct. 1985 - Mar. 1989
R. A. Craig, C. R. Batishko, J. L. Brimhall, W. T. Pawlewicz, and K. A. Stahl Nov. 1989 149 p
(Contract DE-AC06-76RL-01830; AF Proj. ILIR)
(AD-A216005; WL-TR-89-26) Avail: NTIS HC A07/MF A01 CSCL 20/6

Battelle Pacific Northwest Laboratory (PNL) conducted research into the preparation and characterization of ion-implanted adaptive optic elements based on lead-lanthanum-zirconate-titanate (PLZT). Over the 4-yr effort beginning FY 1985, the ability to increase the photosensitivity of PLZT and extend it to longer wavelengths was developed. The emphasis during the last two years was to develop a model to provide a basis for choosing implantation species and parameters. Experiments which probe the electronic structure were performed on virgin and implanted PLZT samples. Also performed were experiments designed to connect the developing conceptual model with the experimental results. The emphasis in FY 1988 was to extend the photosensitivity out to diode laser wavelengths. The experiments and modelling effort indicate that manganese will form appropriate intermediate energy states to achieve the longer wavelength photosensitivity. Preliminary experiments were also conducted to deposit thin film PLZT. GRA

N90-18254# George Mason Univ., Fairfax, VA.
ANALYSIS AND EVALUATION OF TECHNICAL DATA ON THE PHOTOCHROMIC AND NON-LINEAR OPTICAL PROPERTIES OF MATERIALS Quarterly Technical Report No. 4
Robert F. Cozzens 18 Dec. 1989 17 p
(Contract DAAB07-89-C-F404; ARPA Order 6631)
(AD-A216124) Avail: NTIS HC A02/MF A01 CSCL 20/6

The principle goal of this relatively small contractural effort is to provide technical assistance to the DARPA Program Director in evaluating data on materials, especially polymers, that may be useful in the development of limiters and switches for the protection of eyes and electro-optic sensors from exposure to damaging levels of laser radiation. A principle task is to assist in the development of a predicative capability in assessing the viability of various approaches and devices and to assess those theoretical limitations which may exist in the use of organic materials as optical switches and limiters. A search of the literature has been completed for the purpose of gathering into one table the non-linear optical properties, especially values reported for Chi-3, of various organic materials. GRA

N90-18255# Lawrence Livermore National Lab., CA.
INTEGRATED OPTICS AT LAWRENCE LIVERMORE NATIONAL LABORATORY
G. M. McWright, D. A. Lafaw, M. Lowry, B. B. Ross, and W. E. Tindall 1990 8 p Presented at the Department of Defense Fiber Optics Conference, McLean, VA, 20-23 Mar. 1990
(Contract W-7405-eng-48)
(DE90-003015; UCRL-102110; CONF-900333-3) Avail: NTIS HC A02/MF A01

We discuss lithium niobate and gallium arsenide integrated optical device work at Lawrence Livermore National Laboratory. Specifically, we focus on application of these devices to high speed diagnostic systems and fiber optic links. DOE

75 PLASMA PHYSICS

Includes magnetohydrodynamics and plasma fusion.

For ionospheric plasmas see *46 Geophysics*. For space plasmas see *90 Astrophysics*.

N90-18256# Oak Ridge National Lab., TN.
DISSIPATIVE TRAPPED ELECTRON MODES IN ELL EQUALS 2 TORSATRONS
B. A. Carreras, N. Dominguez, V. E. Lynch, and P. H. Diamond (California Univ., San Diego.) 1989 4 p Presented at the 1st International Toki Conference on Plasma Physics and Controlled Nuclear Fusion, Toki, Japan, 4-8 Dec. 1989
(Contract DE-AC05-84OR-21400)
(DE90-004919; CONF-891240-4) Avail: NTIS HC A01/MF A01

Trapped electron modes in stellarators can be more unstable than those in tokamaks. They could be easier to detect in a stellarator and may be responsible for anomalous losses in the low collisionality regime. These theories are examined. DOE

N90-18257# Lawrence Livermore National Lab., CA.
MICROWAVE FREE-ELECTRON LASER APPLICATIONS FOR ELECTRON CYCLOTRON HEATING OF PLASMAS
Keith I. Thomassen 1990 11 p Presented at the SPIE Optics, Electro-Optics, and Laser Applications in Science and Engineering Conference and Exhibition, Los Angeles, CA, 20-25 Jan. 1990 Submitted for publication
(Contract W-7405-eng-48)
(DE90-005203; UCRL-102616; CONF-900140-2) Avail: NTIS HC A03/MF A01

Millimeter wave power may be the ideal source of heat for a plasma, but advances in technology are needed to meet requirements of next generation fusion devices. Free electron lasers (FEL) are one candidate for such sources, and the progress, issues of physics and technology, and potential benefits for fusion from these devices is reviewed. DOE

N90-18258# International Centre for Theoretical Physics, Trieste (Italy).
MAGNETOPLASMA OSCILLATIONS OF THE WAVE-GUIDED TYPE IN SEMICONDUCTOR SUPERLATTICES
J. C. Granada, A. M. Kosevich, and Yu. A. Kosevich (All-Union Surface and Vacuum Research Centre, Moscow, USSR) Jun. 1989 16 p Submitted for publication
(DE90-607260; IC-89/132) Avail: NTIS (US Sales Only) HC A03/MF A01

For electromagnetic wave-guided oscillations of two-dimensional (2D) electron layer periodic array in a transversal magnetic field, the dispersion relation is analyzed. Oscillation frequencies much lower than the electron cyclotron frequency exist under certain conditions. Additionally, the perpendicular propagation to the layers is investigated. It is demonstrated, that a strong magnetic field causes a frequency shift and splitting, which are in inverse relation to the external magnetic field and the period of the layered electron system. DOE

N90-18259# International Centre for Theoretical Physics, Trieste (Italy).
ON THE QUANTUM INVERSE PROBLEM FOR A NEW TYPE OF NONLINEAR SCHROEDINGER EQUATION FOR ALFVEN WAVES IN PLASMA
Shibani Sen and A. Roy Chowdhury (Jadavpur Univ., Calcutta, India) Jun. 1989 12 p Submitted for publication
(DE90-607469; IC-89/131) Avail: NTIS (US Sales Only) HC A03/MF A01

The nonlinear Alfven waves are governed by the Vector Derivative Nonlinear Schroedinger (VDNLS) equation, which for parallel or quasi parallel propagation reduces to the Derivative

Nonlinear Schroedinger (DNLS) equation for the circularly polarized waves. We have formulated the quantum inverse problem for a new type of nonlinear Schroedinger equation which has many properties similar to the usual NLS problem but the structure of classical and quantum R matrix are distinctly different. The commutation rules of the scattering data are obtained and the algebraic Bethe Ansatz is formulated to derive the eigenvalue equation for the energy of the excited states. DOE

N90-18260# International Centre for Theoretical Physics, Trieste (Italy).
GENERATION OF AXIAL AND LATERAL MAGNETIC FIELDS IN LASER PRODUCED PLASMAS
B. Bhattacharyya, H. C. Pant, and Susmita Sarkar (Jadavpur Univ., Calcutta, India) Jun. 1989 7 p Submitted for publication
(DE90-607470; IC-89/152) Avail: NTIS (US Sales Only) HC A02/MF A01

The generation of both axial and lateral magnetic fields caused by the interaction of intense radiations with laser produced plasmas was analytically studied. It is shown that the inverse bremsstrahlung absorption has an impact on the generation of the lateral magnetic field in laser produced plasmas, modifying the lateral thermal energy transport in the coronal region. However, the axial energy transport may remain unaffected. DOE

N90-18261# Institute of Plasma Physics, Prague (Czechoslovakia).
MODEL OF OXYGEN IONS RESONANT LINES EMISSION OF REB-HEATED PLASMA
J. Raus and V. Babicky Jun. 1989 27 p
(IPPCZ-294) Avail: NTIS HC A03/MF A01

Time dependent intensities of selected resonant lines of oxygen impurity in ionization stages O(2+) - O(5+) in hydrogen plasma of n(sub e) about 10(exp 15)/cu cm are calculated by using nonstationary corona model with variable electron temperature of the maximum value of 20 to 50 eV (plasma parameters of REBEX experiment), to judge the possibilities of prepared measurements and to facilitate their interpretation. Simultaneously the rough form of XRD signals corresponding to these parameters and the influence of radiation losses on plasma decay are shown.
Author

N90-18262# Institute of Plasma Physics, Prague (Czechoslovakia).
QUASILINEAR APPROACH TO THE DAMPING OF LH WAVES IN A REACTOR-GRADE PLASMA
P. Pavlo, L. Krlin, and Z. Tluchor 1989 33 p
(IPPCZ-292) Avail: NTIS HC A03/MF A01

The results of computer simulation of the lower hybrid current drive (LHCD) for ITER parameters are presented. The damping of LH waves on alpha particles due to the interaction on high cyclotron resonances is obtained by solving the 2D Fokker-Planck equation with the corresponding quasilinear term (FPA code). This code is incorporated into a 1D LHCD code so as to obtain radial profiles of the RF power deposited to electrons and alpha particles as well as that of the driven current. Noticeable absorption by alpha particles is observed only below 5 GHz of the generator frequency and is bearable down to 3 GHz (22 percent of the input power with only 10 percent reduction of the total driven current for an optimized input spectrum). The absorption is accompanied by acceleration of a group of alpha particles much above their born velocity. The RF induced alpha particles losses are found to be too small to affect the energy balance but may contribute to the deterioration of the first wall. Some further mechanisms not included in the code but having possible effects on the interaction are discussed.
Author

N90-18263# Japan Atomic Energy Research Inst., Tokyo. Dept. of Thermonuclear Fusion Research.
A 13-POINT THOMSON SCATTERING SYSTEM FOR JFT-2M PLASMA
Toshihiko Yamauchi, Richard Neufeld, and Toshihide Ogawa Aug. 1989 17 p
(DE90-733140; JAERI-M-89-104) Avail: NTIS (US Sales Only) HC A03/MF A01

A 13-point Thomson scattering system mounted on the JFT-2M tokamak routinely provides reproducible electron temperature and density data. Good performance was achieved with the help of a large collecting lens (capable of gathering data over a vertical 60-cm long plasma volume), the automatic transfer of data from a 180-channel attenuator into the CPU, the use of high-pass optical filters and a large polarizer plate to reduce stray light, and a better matching of LED calibration signal intensities to those of the scattered signals. Peaked density profiles are measured in improved L-mode (IL) plasmas, in contrast to those observed during the H-mode phase. IL-mode is caused by the broad and high electron temperature. With pellet injection, peaked density profiles are again observed. DOE

N90-18264# Japan Atomic Energy Research Inst., Tokyo. Dept. of Thermonuclear Fusion Research.
NUMERICAL SIMULATION OF NON-INDUCTIVE CURRENT DRIVE FOR TOKAMAK PLASMAS WITH TIME-VARYING ELECTRON TEMPERATURES
C. R. Neufeld, Ryuji Yoshino, Takumi Yamamoto, Yoshihiko Uesugi, and Hisato Kawashima Aug. 1989 14 p
(DE90-733144; JAERI-M-89-103) Avail: NTIS (US Sales Only) HC A03/MF A01

A relatively simple computer simulation program was developed for the investigation of plasma behavior during pulsed heating and current drive experiments. The temporal evolution of various plasma parameters, including the internal electric and poloidal magnetic field distributions, as well as the surface loop voltage, can be simulated under a variety of conditions. The results show clearly the difficulty of using the observed loop voltage behavior alone as a measure of the RF-driven current, unless the plasma parameters have had sufficient time to approach equilibrium conditions during each distinct plasma phase. DOE

N90-18265# Japan Atomic Energy Research Inst., Tokyo. Dept. of Large Tokamak Research.
RESULTS OF THE H-MODE EXPERIMENTS WITH JT-60 OUTER AND LOWER DIVERTORS
Hiroo Nakamura, Shunji Tsuji, Masayuki Nagami, Takahisa Ozeki, Shinichi Ishisa, Masafumi Azumi, Masato Akiba, Toshiro Ando, Tsuneyuki Fujii, and Takeshi Fukuda et al Aug. 1989 58 p
(DE90-733146; JAERI-M-89-106) Avail: NTIS (US Sales Only) HC A04/MF A01

In JT-60, hydrogen H-mode experiments with outer and lower divertors were performed. In the outer divertor, H-mode were obtained, similar to the ones observed in the other lower/upper divertors. Its threshold absorbed power and electron density were 16 MW and 1.8 x 10(exp 19)/cu m. In the two combined heatings with NB+ICRF and NB+LHRF, H-mode discharges are also obtained. Moreover, in new configuration of lower divertor, H-mode phases without and with ELM are obtained. Typical results of the lower divertor are shown to compare the H-mode characteristics between the two configurations. Improvement of the energy confinement time in the two divertors was limited to 10 percent. Analyses on ballooning/interchange instabilities were carried out with precise equlibria of JT-60. These results showed that both modes were stable enough. DOE

N90-18266# Sandia National Labs., Albuquerque, NM.
FIRST PUMP LIMITER EXPERIMENTS IN TORE SUPRA
M. Chattelier, C. C. Klepper, J. L. Brunean, P. Chappius, D. Guilhem, C. Gil, M. Lipa, L. Rodriguez, J. C. Vallet, and D. VanHoutte et al 1989 4 p Presented at the 16th European Conference on Controlled Fusion and Plasma Physics, Venice (Italy), 13-17 Mar. 1989 Prepared in cooperation with Association Euratom-CEA, Saint Paul-les-Durance (France)
(Contracts DE-AC04-76DP-00789; DE-AC05-84OR-21400)
(DE90-004968; SAND-89-2675C; CONF-890302-25) Avail: NTIS HC A01/MF A01

The operation of TORE SUPRA at full power (25MW, 30s)

has led to the design of a full set of actively pumped carbon limiters to remove at least 8MW and to partially control the particle balance. An interim version is now installed, composed of 5 vertical and one horizontal outboard (OPL) pump limiters, semi-inertially water cooled. The latter is a result of a collaboration between the U.S. DOE and the Association EUR-CEA, it is fully instrumented and therefore can serve as a reference for the final design. Ohmic discharges (1.85T, 740kA, 8.5s) in helium were used to test the thermal load on and the particle exhaust efficiency of the OPL. In these experiments the plasma is formed on the inner wall (R = 232 cm, a = 76 cm) and subsequently displaced (6 cm) outward, early on the current plateau, to lean on the OPL (R = 238 cm, a = 75 cm). In addition to the limiters above, a non-pumped outboard (ONLP) limiter of identical shape to the OPL served to produce similar discharges for better comparison and determination of particle control. A comparison is made hereafter of the thermal load and particle pumping effects on the OPL when the plasma is in contact either with the OPL/ONPL alone or with the OPL and the vertical limiters together. DOE

N90-18267# Department of Energy, Washington, DC. Energy Research Advisory Board.
COLD FUSION RESEARCH Final Report
Nov. 1989 90 p
(DE90-005611; DOE/S-0073) Avail: NTIS HC A05/MF A01

The current status of cold fusion is reviewed and included are the major chapters on Calorimetry and Excess Heat, Fusion Products and Materials Characterization. In addition, a number of conclusions and recommendations are made, as requested by the Secretary of Energy. DOE

N90-18268# Wisconsin Univ., Madison. Plasma Physics Research.
FIRST RESULTS FROM THE MST (MADISON SYMMETRIC TORUS) REVERSED FIELD PINCH
A. F. Almagri, S. Assadi, J. A. Beckstead, R. N. Dexter, D. J. DenHartog, G. Chartas, S. A. Hokin, T. W. Lovell, S. C. Prager, and T. D. Rempel et al Nov. 1989 11 p Sponsored by DOE, Washington, DC
(DE90-005743; DOE/ER-53198/147) Avail: NTIS HC A03/MF A01

The first period of physics operation of the Madison Symmetric Torus (MST) reversed field pinch has produced information on sawtooth oscillations, edge magnetic and electrostatic fluctuations, and equilibrium parameters at large plasma size. Sawtooth oscillations are prevalent at all values of pinch parameter, and might constitute discrete dynamo events. Both electrostatic and magnetic fluctuations are of sufficient magnitude to be relevant to transport in the RFP. In the plasmas studied to date (up to a plasma current of 0.5 MA) the poloidal beta value is about 10 percent, or greater. DOE

N90-18269# Lawrence Livermore National Lab., CA.
OVERVIEW OF DEFENSE APPLICATIONS OF ICF (INERTIAL CONFINEMENT FUSION)
William J. Hogan and Michael T. Tobin 15 Aug. 1989 9 p
(Contract W-7405-eng-48)
(DE90-005745; UCID-21837) Avail: NTIS HC A02/MF A01

The objective of the Inertial Confinement Fusion (ICF) Program is to demonstrate a significant fusion capability in the laboratory. The applications of ICF are broad and numerous, ranging from basic and applied science to weapons physics and weapons effects to energy production and eventually space power and propulsion. This paper is limited to a brief summary of the applications of ICF to defense programs, and in particular, the nuclear weapons R and D and technology base. While relevant weapons physics experiments are currently conducted using the Nova laser, the ultimate contribution of ICF in this area will be a Laboratory Microfusion Facility (LMF) in which fusion yields of 100 to 1000 MJ, provided in a single experimental shot, can be used to attain the near-term applications. DOE

N90-18270# Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).
ANOMALOUS PARTICLE DIFFUSION THROUGH A MAGNETIC PICKET FENCE
J. L. Ferreira, G. O. Ludwig, J. G. Ferreira, and A. Montes Jun. 1989 18 p Presented at the Spring College on Plasma Physics, Trieste, Italy, 15 May - 9 Jun. 1989
(INPE-4841-PRE/1470) Avail: NTIS HC A03/MF A01

Electron and ion diffusion through magnetic fields is one of the most important branchs of plasma confinement physics. Recently many efforts to improve ion sources based on surface confined quiescent plasmas have axed an understanding of particle diffusion through magnetic multidipole fields. The measurement of the electron diffusion coefficient is described through the multidipole fields of a surface confined quiescent plasma generated by a thermionic discharge with oxided coated tungsten filaments. Plasma potential, density, and temperature profiles were obtained using emissive probes, Langmuir probes, and grid energy analyzers. The diffusion coefficient calculated from these profiles is bigger than the classical one, indicating an anomalous transport process in operation. Further measurements using a Langmuir probe connected to a spectrum analyzer have disclosed the existence of large amplitude ion acoustic turbulence in the magnetic sheath. The space profile of the turbulent wave's relative amplitude shows an anomalous diffusion process driven by an ion acoustic instability. Author

N90-18271# Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil). Ministerio da Ciencia e Tecnologia.
PLASMA DIAGNOSTICS GENERATED IN THE COMPACT TORUS OF UNICAMP
Mario Ueda, Yoshiaki Doi, Emilia AkemiAramaki, Roberto YzumiHonda, Peterson Porto, and Luiz Berni Aug. 1989 40 p In PORTUGUESE; ENGLISH summary
(INPE-4862-RPE/593) Avail: NTIS HC A03/MF A01

Experiments are described which were carried out in the Compact Torus of UNICAMP (TC-1): (1) summary of TC-1 characteristics and its operation mode; (2) description of diagnostics in use and ones to be installed; and (3) recent experimental results using optical and electromagnetical diagnostics. Author

N90-18272# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
PLASMA MODIFICATION OF POLY (P-PHENYLENEBENZOBISTHIAZOLE) M.S. Thesis
Patrick E. Godfrey Dec. 1989 82 p
(AD-A215761; AFIT/GEP/ENP/89D-4) Avail: NTIS HC A05/MF A01 CSCL 20/9

A plasma treatment chamber was constructed and used to treat samples of poly p-phenylene benzobisthiazole (PBZT), an ordered polymer material. Analysis of scanning electron microscope results showed that exposure to an argon glow discharge plasma for extended times eroded the surface of the polymer. X ray photoelectron spectroscopy indicated that oxides were formed on the plasma treated surfaces upon exposure to air. Treatment using argon, argon/water vapor and nitrogen plasmas was shown to make the polymer surfaces more hydrophilic. PBZT films bonded between aluminum coupons failed cohesively when shear forces were applied. Plasma treatment improved the shear strength of PBZT films by over 50 percent. This improvement is attributed to an enhancement of the interlaminar strength of the PBZT via crosslinking between polymer chains. GRA

N90-18273# Research Triangle Inst., Research Triangle Park, NC.
INVESTIGATION OF LOW TEMPERATURE MULTILEVEL DIELECTRICS FOR APPLICATION FOR RADIATION TOLERANT, SUBMICRON-SCALED IC TECHNOLOGY
Quarterly Report No. 1, 1 Jan. - 31 Mar. 1989
J. A. Hutchby, R. J. Markunas, S. V. Hattangady, G. G. Fountain, G. Lucovsky, D. V. Tsu, and S. S. Kim (North Carolina State Univ., Raleigh.) 15 Apr. 1989 8 p

(Contract N00014-86-C-0421)
(AD-A216114; RTI-415U-3627-1QTR) Avail: NTIS HC A02/MF A01 CSCL 20/3

This program entails a joint effort between Research Triangle Institute and North Carolina State University. During this quarter we have made a preliminary comparison of SiO2 deposited at 1.1 to 1.2 nm per minute and 0.16 to 0.18 nm per minute, both at low pressure. An investigation has been carried out to look at the effect of the extension of the glow discharge region using a grounded vs. floating grid between the plasma tube and the sample to control the extent of the plasma. GRA

N90-18274# San Diego State Univ., CA. Dept. of Electrical and Computer Engineering.
ELECTRON PRODUCTION, ELECTRON ATTACHMENT, AND CHARGE RECOMBINATION PROCESS IN HIGH PRESSURE GAS DISCHARGES Final Report, 1 Aug. 1986 - 31 Jul. 1989
Long C. Lee 25 Sep. 1989 67 p
(Grant AF-AFOSR-0205-86; AF Proj. 2301)
(AD-A216301; AFOSR-89-1694TR) Avail: NTIS HC A04/MF A01 CSCL 20/9

Electron transport parameters for gaseous mixtures containing electro-negative gases in buffer gases were investigated in this research program. Absolute electron attachment rate constants and cross sections of halogen compounds were measured. Photodetachment cross sections of halogen negative ions in discharge media were determined. Discharge current switching induced by laser irradiation of discharge media was observed. These basic data are obtained for the development of various gaseous discharge switches and for the study of basic discharge phenomena as well. High repetition-rate discharge switches, opening switches, and radiation or e-beam controlled switches are needed for the development of high power lasers, fusion experiments, magnetic energy storage systems, and particle beam experiments. High pressure gaseous discharges could be used for the development of these switches. The measured electron transport parameters are needed for determining the rise and decay times of discharge pulses, discharge stability, discharge uniformity, and current density. GRA

N90-18275# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
A NUMERICAL SOLUTION OF THE TIME-DEPENDENT BOLTZMANN EQUATION M.S. Thesis
Gaylord E. Seger, III Dec. 1989 90 p
(AD-A216397; AFIT/GEP/ENP/89D-10) Avail: NTIS HC A05/MF A01 CSCL 20/9

Interest in gas discharge phenomena for laser, ion source, and plasma processing applications has generated needs for the solution of the time-dependent Boltzmann Equation. An algorithm is developed and tested to compute the electron energy distribution function (EDF), incorporating elastic, inelastic, superelastic, ionization, and electron-electron collisions. A new finite differencing approach which eliminates low energy instabilities inherent in previous techniques is developed and tested. An implicit-explicit Euler approximation technique was used for the algorithm to transform the resulting nonlinear differential equation into a system of finite differenced linear equations. The system is then solved using LU-decomposition for efficient matrix computation. The program developed using this algorithm, MEGABOLTZ, is first put through basic shakedown tests to verify the correctness of the algorithm. Next, the program calculates an EDF for nitrogen gas for electric field to neutral number density ratios (E/N) ranging from 5 to 40 Townsend. Distributions computed by MEGABOLTZ were compared to previously reported data from other Boltzmann Equation solvers and experiments, and are found to be in good agreement with them. Future modifications are suggested for MEGABOLTZ to improve robustness and accuracy. A short user's manual for MEGABOLTZ is also included. GRA

N90-18336*# Physical Sciences, Inc., Andover, MA.
REPORT FROM SPACE PLASMA SCIENCE
D. E. Hastings, A. Drobot, Peter M. Banks, W. W. L. Taylor, and H. R. Anderson (Rice Univ., Houston, TX.) *In* NASA, Marshall Space Flight Center, Solar-Terrestrial Science Strategy Workshop Sep. 1989 p 51-59 (For primary document see N90-18329 10-88)
Avail: NTIS HC A04/MF A01; 4 functional color pages CSCL 20I

76 SOLID-STATE PHYSICS

Includes superconductivity.

For related information, see also *33 Electronics and Electrical Engineering* and *36 Lasers and Masers.*

N90-18276# Sandia National Labs., Albuquerque, NM.
CURRENT STATUS OF InAsSb STRAINED LAYER SUPERLATTICE INFRARED DETECTORS: DEMONSTRATION OF A HIGH DETECTIVITY, 10 MICRON PHOTODIODE
S. R. Kurtz, L. R. Dawson, T. E. Zipperian, and R. D. Whaley, Jr. 1989 13 p Presented at the IRIS Conference, Monterey, CA, 14-17 Aug. 1989
(Contract DE-AC04-76DP-00789)
(DE90-000800; SAND-89-1900C; CONF-8908159-1) Avail: NTIS HC A03/MF A01

A high detectivity infrared photodiode was constructed using an InAs(0.15)Sb(0.85)/InSb strained layer superlattice (SLS). The surface passivated device exhibited detectivities greater than or = x 10(exp 10) cm the square root of Hz/W at wavelengths less than or = 10 microns. This device demonstrates the feasibility of a long wavelength, photovoltaic infrared detector technology based on InAsSb SLSs. DOE

N90-18277# Paris VI Univ. (France).
INTERNATIONAL SUMMER SCHOOL ON SOLID STATE MICROBATTERIES
1988 602 p School held in Paris, France
(Contract DAJA45-88-M-0152)
(AD-A213457; R/D-5976-PH-02) Avail: NTIS HC A99/MF A04 CSCL 10/3

Some of the courses taught at the school are listed: Optical Characterization of Semiconductor Materials and Structures; High Resolution Electron Microscopy of Defects in Silicon; Crystalline Silicon Solar Cells, Heavy Doping Effects and Their Influence on Silicon Bipolar Transistors; Silicon Molecular Beam Epitaxy (Status, Devices, Trends); Rechargeable Solid State Cells; Thin Film Technology and Characterization (Their Use In Microionic Devices); Modeling, Fabrication, and Development of Miniature Sensors; Simulation of Silicon Processing-I; 4M Technology; Theory of Defects in Crystalline Silicon; Amorphous Room Temperature Polymer Solid Electrolytes; Advanced Silicon on Insulator Materials (Processing, Characterization and Devices); Diamond Lattice, Structure and Possible Applications for Porfluorinated Ionomers in Solution; Theory and Applications of Amorphous Solid for Electrochemical Cells; The Physical Formation Processes of Thin Films; Their Characterization by XPS, AES and SIMS and Their Applications in Micro batteries; Chemistry, Physics and Applications of Polymeric Solid Electrolytes to Micro batteries; Space Radiation Effects in MOS Devices; and Fundamentals of Low Temperature Silicon Epitaxy. GRA

N90-18278# Army Lab. Command, Watertown, MA. Material Technology Lab.
STRUCTURAL, MAGNETIC AND ELECTRICAL PROPERTIES OF La(SUB 2-x) Ba(SUB x) NiO4
Amy B. Austin (Watkins-Johnson Co., Palo Alto, CA.), Louis G. Carreiro, and James V. Marzik 1989 16 p Repr. from Materials Research Bulletin, v. 24, 1989 p 639-646
(DA Proj. 1L1-61102-AH-42)
(AD-A214347; MTL-TR-89-79) Avail: NTIS HC A03/MF A01 CSCL 07/2

Polycrystalline samples of the composition La(2-x)Ba(x)NiO4 were prepared by standard solid state chemistry techniques. The samples were characterized by x ray diffraction, magnetic

susceptibility in the temperature range 6 to 300 K, and room temperature electrical resistivity. The effect of barium substitution on the structural, magnetic, and electrical properties is reported. GRA

N90-18279# Tufts Univ., Medford, MA. Electro-Optics Technology Center.
REFLECTANCE MODULATION WITH ELECTROCHROMIC LI(SUB x)WO(3) FILMS
R. B. Goldner, G. Berera, F. O. Arntz, T. E. Haas, B. Morel, and K. K. Wong 1989 10 p Presented at the Electrochemical Society Fall Meeting, Hollywood, FL, 15-20 Oct. 1989 Submitted for publication
(Contract DE-FG03-85SF-15927)
(DE90-004571; CONF-8910107-6) Avail: NTIS HC A02/MF A01

Reflectance-modulated Smart Glass Windows (or smart windows) is a potentially important application for electrochromic thin films. The question addressed, what is the upper bound for the near infrared reflectivity modulation in Li(x)WO3 films. Based upon recent research on bulk crystals of Na(x)WO3 and bulk crystals and thin films of polycrystalline Li(x)WO3, it is concluded that the upper bound is probably close to that of bulk crystals of Na(x)WO3 (x greater than 0.5) for which near infrared reflectance greater than 90 percent has been reported. DOE

N90-18280# Los Alamos National Lab., NM. Materials Science and Technology Div.
INFLUENCE OF ION BEAM MIXING ON THE GROWTH OF HIGH TEMPERATURE OXIDE SUPERCONDUCTING THIN FILM
Nicole Bordes, Anthony D. Rollett, Michael R. Cohen, and Michael Nastasi 1989 7 p Presented at the Materials Research Society Fall Meeting, Boston, MA, 27 Nov. - 2 Dec. 1989
(Contract W-7405-eng-36)
(DE90-004837; LA-UR-89-4080; CONF-891119-52) Avail: NTIS HC A02/MF A01

The superconducting properties of high temperature superconductor thin films are dependent on the quality of the substrate used to grow these films. In order to maximize the lattice matching between the superconducting film and the substrate, a YBa2Cu3O7 thin film deposited on less than 100 greater than SrTiO3 was used as a template. The first film was prepared by coevaporation of Y, BaF2 and Cu on less than 100 greater than SrTiO3, followed by an anneal in wet oxygen at 850 C. This film showed a sharp transition at about 90 K. A thicker layer of about 5000 A was then deposited on top of this first 2000 (angstrom) film, using the same procedure. After the post anneal at 850 C, the transition took place at 80 K and no epitaxy of the second film was observed. Ion beam mixing at 400 C, using 400 keV O ions was done at the interface of the two films (the second one being not annealed). After the post anneal, the film displayed an improved Tc at 90K. Moreover, epitaxy was shown to take place from the interface SrTiO3-123 film towards the surface and was dependent of the dose. These results are discussed from the data obtained from Rutherford backscattering spectroscopy (RBS) combined with channeling experiments, x ray diffraction (XRD) and scanning electron microscopy (SEM) observations. DOE

N90-18281# Los Alamos National Lab., NM.
THERMAL CONDUCTIVITY OF QUASI-ONE DIMENSIONAL CONDUCTORS
R. S. Kwok and S. E. Brown (Florida Univ., Gainesville.) 1989 6 p Presented at the 3rd European Conference on Low Dimensional Conductors and Superconductors, Croatia, Yugoslavia, 18-22 Sep. 1989
(Contract W-7405-eng-36; NSF DMR-86-20340)
(DE90-004844; LA-UR-89-4157; CONF-8909279-1) Avail: NTIS HC A02/MF A01

The thermal conductivity of K(0.3)MoO3, (TaSe4)2I and TaS3 were studied. Together with the specific heat measurement, the anomaly observed in thermal conductivity around the Peierls transition is believed to be due to extra heat carried by the 2k(sub F) soft phonons. The field dependent thermal conductivity of the blue bronze and TaS3 were also measured by two distinct methods, and found to be independent of applied electric field. DOE

N90-18282# Battelle Memorial Inst., Columbus, OH.
CRITICAL FIELD ENHANCEMENT DUE TO FIELD PENETRATION IN FINE-FILAMENT SUPERCONDUCTORS
E. W. Collings, A. J. Markworth, J. K. McCoy, K. R. Marken, Jr., M. D. Sumpption, E. Gregory, and T. S. Kreilick (Supercon, Inc., Shrewsbury, MA.) 1989 7 p Presented at the International Cryogenic Materials Conference, Los Angeles, CA, 24-28 Jul. 1989
(Contract DE-AC02-86ER-40296)
(DE90-005389; CONF-890701-24) Avail: NTIS HC A02/MF A01

In samples in which at least one dimension, say 2R, is comparable to a penetration depth, lambda(sub L), the flux-exclusion volume at fields below H(sub c1) is less than the true sample volume. This volume erosion has two important consequences: (1) it causes the Meissner susceptibility to be less than the standard value -- for example, for a field-parallel plate, by a factor 1-(1/x)tanh(x), where x = R/lambda(sub L); (2) it reduces the flux-exclusion energy density (based on the initial sample volume) by the square of that factor. In the latter case it calls for an enhanced applied field strength to terminate the Meissner state -- that enhancement factor being accordingly 1/the square root of 1-(1/x)tanh(x). Both of these effects become more and more pronounced as T approaches (Tc), since the field penetration depth increases with temperature according to 1/the square root of 1-t(sup 4), where t (identical to) T/(Tc). The susceptibility-depletion and field-enhancement effects have been studied on a series of very fine filament composites (with NbTi filament diameters ranging from 0.5 to 11.6 microns), prepared from 23,000-filament NbTi/CuMn strands from which (to avoid unwanted proximity effect coupling) the Cu was removed by etching and replaced by epoxy. For example, at 4.2 K in the finest-filament material, susceptibility was found to be 1/15 of the Meissner value, and the sample exhibited a lower critical applied field of 607 gauss. DOE

N90-18283# Department of the Navy, Washington, DC.
HIGH QUALITY TUNNEL JUNCTION DEVICES USING HIGH T(SUB c) SUPERCONDUCTORS Patent Application
Robert J. Soulen, inventor (to Navy) and Stuart A. Wolf, inventor (to Navy) 30 Jun. 1989 14 p
(AD-D014329; US-Patent-Appl-SN-373555) Avail: NTIS HC A03/MF A01 CSCL 20/12

This invention relates generally to superconducting devices and, specifically, to tunnel junctions and Josephson junctions in superconducting devices. A structure and method for fabricating tunnel junctions from high transition temperature material are disclosed. A tunnel junction consists of three films successively deposited on a substrate: a superconductor, an insulator or normal metal and a superconducting or normal metal. The critical interface is between the superconductor and the insulator or normal metal. Previous attempts to form tunnel junctions have used the upper surface of the superconductor which is invariably rough and inhomogeneous. This invention uses the lower surface which is more epitaxial to fabricate tunnel junctions and Josephson junctions. GRA

N90-18284# Princeton Univ., NJ. Dept. of Physics.
EXPERIMENTS ON LARGE SINGLE CRYSTALS OF THE SUPERCONDUCTING OXIDES YBa2Cu3O7, La SUB 2-xBa SUB xCuO4, AND Bi-Ca-Sr-O Final Report, 2 Oct. 1988 - 28 Feb. 1989
N. Phuan Ong 30 Oct. 1989 4 p
(Grant AF-AFOSR-0022-89; AF Proj. 2306)
(AD-A215283; AFOSR-89-1574TR) Avail: NTIS HC A01/MF A01 CSCL 20/3

The growth and characterization of single crystals of the high temperature superconductors was investigated. High temperature, high pressure annealing of crystals of YBCO was carried out and

found to be ineffective in further raising the Tc of the crystals beyond 93 K. Torque magnetometry measurements on YBCO crystals showed that the coherence length anisotropy is 5.5, independent of temperature in the range 80 to 90 K. The growth of the 40 K system based on LaCuO doped with Ba, was attempted. Large crystals were obtained, but the Ba content (x approx. 0.5) was too high to sustain high temperature superconductivity. GRA

N90-18285# Naval Research Lab., Washington, DC. Chemistry Div.
THERMAL CRYSTALLIZATION OF POLYTETRAHYDROFURAN NETWORKS Technical Report, No. 7, May - 30 Sep. 1989
C. Michael Roland and Gary S. Buckley 8 Nov. 1989 21 p
(AD-A215336) Avail: NTIS HC A03/MF A01 CSCL 20/2

The thermal crystallization behavior of cross-linked rubbers formed by endlinking monodisperse and bidisperse linear polytetrahydrofurans (PTHF) was investigated. The introduction of crosslinkages in PTHF inhibits the ability of chain units in proximity to the crosslinks to crystallize. From melting point depression measurements, it is estimated that the suppression in crystallizability extends as much as 15 chain units away from the crosslinkage. This estimate is consistent with the degree of equilibrium crystallinity measured in the various PTHF networks. The equilibrium melting point for uncrosslinked PTHF was deduced from melting point depression in the crosslinked rubbers to be 368 K. This is in satisfactory agreement with the T determined linear PTHF, 361 K, but significantly higher than previously reported values. The distribution in the lengths of network chains exerted a trivial influence on thermal crystallization behavior, at least under the present experimental conditions. GRA

N90-18286# Varian Associates, Palo Alto, CA.
HIGH TEMPERATURE SUPERCONDUCTIVITY Annual Report, period ending 30 Jun. 1989
James N. Eckstein 30 Jun. 1989 7 p
(Contract N00014-88-C-0760)
(AD-A215491) Avail: NTIS HC A02/MF A01 CSCL 20/3

The overall goals of this program are to develop the technology of molecular beam epitaxy (MBE) growth of high temperature superconductor (HTSC) material, to optimize the performance of HTSC films with high transition temperatures and critical current densities, and to explore the development of electronic devices based on such material. In-situ growth of (BiO)2-containing HTSC material was obtained. Attempts are being made to perfect the process in order to improve the superconducting properties of the films. (BiO)2 containing layered superconducting films grown in-situ at low temperature were obtained without any post-growth anneal. This result was obtained recently on two films grown under nominally identical conditions using ozone as a source of active oxygen. To our knowledge, these are the first films from the (BiO)2 family grown in-situ by an evaporative technique, and the first such films grown in-situ by any technique in the U.S. The films were grown on SiTiO3 by atomic layer epitaxy (ALE) and exhibited a streaky RHEED pattern throughout growth, indicating the heteroepitaxy of a single-crystal-like and atomically smooth layer. X ray diffraction analysis revealed the films to be completely aligned, as layered by the beam-shuttering sequence, and nearly single phase. GRA

N90-18287# Argonne National Lab., IL. Materials Science Div.
ANISOTROPY AND DIMENSIONALITY IN UNTWINNED CRYSTALS OF YBa2Cu3O(7-DELTA)
G. W. Crabtree, U. Welp, W. K. Kwok, K. G. Vandervoort, M. M. Fang, M. Grimsdicth, and J. Z. Liu (California Univ., Davis.) 1989 21 p Presented at the International Conference on High-Tc Thin Films and Single Crystals, Ustron, Poland, 30 Sep. - 4 Oct. 1989 Submitted for publication Sponsored in part by Science and Technology Center, Illinois Univ., Urbana
(Contract W-31-109-eng-38; NSF STC-88-09854)
(DE90-004890; CONF-890939-3) Avail: NTIS HC A03/MF A01

A review of dc magnetization measurements of the superconducting transition in twinned and untwinned single crystals of YBa2Cu3O(7-delta) is presented. The upper critical fields derived from the onset of diamagnetism are a factor of 3 to 4 times larger than those determined from the zero resistance temperature. The magnetic upper critical fields are linear in temperature with an anisotropy in slope of approx. 5 between the c direction and the ab plane. The angular dependence of the upper critical field implies 3-D behavior. A crossover to layered behavior is estimated to occur at approx. 74 K. In untwinned crystals produced by uniaxial strain technique, there is no detectable anisotropy in the upper critical field in the ab plane, implying that the one dimensional Cu-O chains do not play a significant role in determining the superconducting properties. DOE

N90-18288# Oak Ridge National Lab., TN.
CRYSTAL AND MAGNETIC STRUCTURE OF Er(2)(Co(SUB x)Fe(SUB 1-x))(17) COMPOUNDS
R. Kumar and W. B. Yelon (Missouri Univ., Columbia.) 1989 15 p Presented at the 34th Conference on Magnetism and Magnetic Materials, Boston, MA, 28 Nov. - 1 Dec. 1989
(Contract DE-AC05-84OR-21400)
(DE90-004928; CONF-891117-13) Avail: NTIS HC A03/MF A01

Room temperature neutron diffraction spectra on compositions x = 0.0, 0.20, 0.40, 0.55, 0.80, and 1.0 were obtained and analyzed for crystal and magnetic structures. The crystal structures deviate from the ideal Th2Ni17 structure, as was observed in the other hexagonal 2 to 17 materials. The structure analysis from the nuclear intensities at 350 K leads to a precise stoichiometry of Er(1.91)Fe(18.25) in Er(2)Fe(17). Because of the high Tc of the Co-rich compounds, the Er atoms align at relatively high temperature and the axial Er anisotropy dominates at room temperature. Only at x = 0.4 composition is a spin reorientation from planar to axial observed below room temperature. The f site, which is analogous to the c site in rhombohedral Th2Zn17 and the j(sub 2) site in Re2Fe14B, does not support a moment as large as on the c site and j(sub 2) site in the respective phases. The moment reduction is probably related to atomic defects on the dumbbell f site. DOE

N90-18289# Lawrence Livermore National Lab., CA.
LONG LASER-PULSE METHOD OF PRODUCING Y-Ba-Cu-O SUPERCONDUCTING FILMS
M. Balooch, D. R. Olander, R. E. Russo (California Univ., Berkeley. Lawrence Berkeley Lab.), and W. J. Siekhaus 21 Nov. 1989 5 p Presented at the Materials Research Society Fall Meeting, Boston, MA, 27 Nov. - 2 Dec. 1989 Submitted for publication
(Contracts W-7405-eng-48; DE-AC03-76SF-00098)
(DE90-005202; UCRL-102452; CONF-891119-62) Avail: NTIS HC A01/MF A01

The quality of superconducting thin films evaporated from YBa2Cu3O7 targets was improved using a long pulse (ms) Nd-glass laser with 50 J pulse energy. The film produced on SrTiO3, held at 690 C, and post annealed at 880 C for about three hours began the transition to superconductivity at 85 K and had zero resistance at 79 K. The observed variation in film thickness corresponded to diffuse emission from the target, and no significant variation in composition as a function of angle of emission up to 40 deg with respect to surface normal was seen. DOE

N90-18290# Battelle Columbus Labs., OH.
EFFECT OF MANGANESE ADDITIONS ON THE PHYSICAL AND SUPERCONDUCTING PROPERTIES OF Nb-46.5Ti
E. W. Collings, K. R. Marken, Jr., J. C. Ho, and T. S. Kreilick (Supercon, Inc., Shrewsbury, MA.) 1988 14 p Presented at the International Conference on Cryogenic Materials: Applications and Properties, Shenyang (Peoples Republic of China), 7-10 Jun. 1988
(Contract DE-AC02-86ER-40296)
(DE90-005393; CONF-880653-5) Avail: NTIS HC A03/MF A01

Some physical and superconductive properties of Nb-46.5Ti doped with (nominally) 2, 4, and 6 wt percent Mn were studied. Properties measured were: residual resistivity, magnetic susceptibility, low-temperature specific heat (which yields the

transition temperature, (Tc), the Debye temperature, and the electronic specific heat coefficient), and (in the case of Cu-clad monofilamentary strands) upper critical field and critical current density, J(sub c). The beta-stabilizing strength of Mn, estimated from metallurgical data, is six times greater (on a weight basis) than that of Nb. Superconductive property evidence places it as an even stronger beta stabilizer. As a result of the tendency of Mn to suppress the precipitation of alpha phase, the J(sub c) of commercially processed Cu-clad Nb-46.5Ti-base monofilamentary strands decreases rapidly with Mn content to such and extent that Nb-46.5Ti-6Mn exhibits a peak effect. DOE

N90-18291# Lawrence Livermore National Lab., CA.
ALFVEN WAVE STABILITY IN D III-D
R. B. Campbell and T. K. Samec (TRW Defense and Space Systems Group, Redondo Beach, CA.) Sep. 1989 41 p
(Contract W-7405-eng-48)
(DE90-005555; UCRL-21282) Avail: NTIS HC A03/MF A01

Within the framework of the global Alfven eigenmode theory in a cylindrical background plasma, the excitation of global Alfven eigenmodes was examined by intense neutral beam injection in the D III-D tokamak operating at General Atomics. Two separate sets of experimental conditions were considered, a low power set of cases using 10 MW of hydrogen beams, and a high power shot of 20 MW of deuterium beams. The results are particularly sensitive to the background density profile. For parabolic background density profiles, n(sub 0) x (1 - (r/the Hermitian congugate of a) squares), it was determined that the plasma is stable to all toroidal and poloidal mode numbers for both high and low power cases. For density profiles which are of the form n(sub 0) x the square root of (1 - (r/the Hermitian congugate of a) squared) for the same n(sub 0), my calculation indicates that the m = -1, l = 0 mode is unstable in each case. The high power case has a considerably higher growth rate at the baseline conditions, which caused this case to be studied more extensively. The results are also sensitive to the beam source radial scalelength, L(sub s), and the electron temperature T(sub e). By narrowing the source from the baseline 36 cm to 20 cm, the growth rate of the (0, -1) actually decreases, but the (0, -2) mode appears with a substantial growth rate. If the source could be made even narrower, L(sub s) is approximately 10 cm, the (1, -1) mode would appear, also with a large growth rate. DOE

N90-18292# Argonne National Lab., IL. Materials and Components Technology Div.
HYPER- AND HYPOBARIC PROCESSING OF Tl-Ba-Ca-Cu-O SUPERCONDUCTORS
K. C. Goretta, J. L. Routbort, Donglu Shi, J. G. Chen, and M. C. Hash Nov. 1989 4 p Presented at the Materials Research Society Fall Meeting, Boston, MA, 27 Nov. - 2 Dec. 1989
(Contract W-31-109-eng-38)
(DE90-005637; CONF-891119-70) Avail: NTIS HC A01/MF A01

Tl-based superconductors of initial composition Tl:Ca:Ba:Cu equal to 2:2:2:3 and 1:3:1:3 were heated in oxygen at pressures of 10(sup 4) to 6 (times) 10(sup 5) Pa. The 2:2:2:3 composition formed primarily the 2-layer superconductor with zero resistance from 77 to 104 K. The 1:3:1:3 composition formed nearly phase pure 3-layer superconductor with a maximum zero resistance temperature of 120 K. Application of hyperbaric pressure influenced phase purities and transition temperatures slightly; phase purities decreased significantly with application of hypobaric pressures. DOE

N90-18293# Argonne National Lab., IL. Materials Science Div.
CHEMISTRY OF THE DOPING MECHANISM IN Ba(1-x)K(x)BiO3 AND La2CuO(SUB 4 + DELTA) OXIDE SUPERCONDUCTORS
D. G. Hinks, J. D. Jorgenen, D. R. Richards, B. Dabrowski, Ying Zheng, and Shiyon Rei 1989 10 p Presented at the International Chemical Congress of Pacific Basin Society Symposium on Polymer Rheology and Processing (PACIFICHEM '89), Honolulu, HI, 17-22 Dec. 1989 Prepared in cooperation with Wisconsin Univ., Madison
(Contract W-31-109-eng-38; NSF STC-88-09854)
(DE90-005640; CONF-891206-10) Avail: NTIS HC A02/MF A01

The chemistry involved in doping oxide materials to form metallic, superconducting compounds can be far from simple. Recent work on two materials, Ba sub 1-x K sub x BiO3 and La2 CuO sub 4+(delta), show the range of complex chemistry involved. DOE

N90-18294# Lawrence Livermore National Lab., CA.
THE ELECTRONIC STRUCTURE OF SIGMA 5 GRAIN BOUNDARIES IN Cu
Erik C. Sowa, A. Gonis, and X. C. Zhang Dec. 1989 6 p Presented at the Materials Research Society Fall Meeting, Boston, MA, 27 Nov. - 2 Dec. 1989 Submitted for publication
(Contract W-7405-eng-48)
(DE90-005999; UCRL-101556; CONF-891119-75) Avail: NTIS HC A02/MF A01

First-principles calculations of the densities of states (DOS's) of unrelaxed and relaxed twist and tilt grain boundaries (GB's) in Cu are presented. The relaxed configurations were obtained through the use of the Embedded Atom Method (EAM), while the DOS's were calculated using the real space multiple scattering theory (RSMST) approach recently introduced in the literature. The DOS's of GB's are compared against those of bulk materials as well as against one another. Although the RSMST calculations are still not self consistent, these comparisons allow us to verify certain expected trends in the DOS's, and to verify the usefulness and reliability of the method. DOE

N90-18295# Connecticut Univ., Storrs. Dept. of Mechanical Engineering.
A MICROMECHANICAL VISCOPLASTIC STRESS-STRAIN MODEL WITH GRAIN BOUNDARY SLIDING
E. H. Jordan 1990 4 p
(Contract DE-FG02-88ER-13894)
(DE90-006013; DOE/ER-13894/2) Avail: NTIS HC A01/MF A01

The goal of the project is the construction and verification of a visco-plastic stress-strain behavior model of a polycrystalline metal where the polycrystalline behavior is derived from single crystal behavior in a manner that accounts for the interaction of differently oriented grains and the single crystal model is derived from postulated slip behavior on individual slip systems. Included in the model will be representation of grain boundary slip. A vital aspect of the project will be the direct verification of the model by doing tests on single crystals to determine actual stress strain-time behavior and use that data to determine the constants describing the single crystal behavior. The knowledge of the single crystal behavior will then be used to predict the polycrystalline behavior. This prediction will be critically tested using additional data on the polycrystalline behavior of the same metal. DOE

N90-18296# California Univ., Berkeley. Lawrence Berkeley Lab. Center for Advanced Materials.
ELECTRON SCATTERING BY NATIVE DEFECTS IN UNIFORMLY AND MODULATION DOPED SEMICONDUCTOR STRUCTURES
W. Walukiewicz Nov. 1989 11 p Presented at the Materials Research Society Fall Meeting, Boston, MA, 27 Nov. - 2 Dec. 1989
(Contract DE-AC03-76SF-00098)
(DE90-006084; LBL-28105; CONF-891119-78) Avail: NTIS HC A03/MF A01

Formation of native defects in GaAs is described in terms of the amphoteric native defect model. It is shown that Fermi energy induced formation of gallium vacancies is responsible for the limitations of maximum free electron concentration in GaAs. The effect of the defects on electron mobility in heavily doped n-GaAs is quantitatively evaluated. Defect scattering explains the abrupt reduction of electron mobility at high doping levels. Also, it is demonstrated that native defects are responsible for the mobility

reduction in inverted modulation doped GaAs/AlGaAs heterostructures. The amphoteric defect model also explains a distinct asymmetry in defect formation in n- and p-GaAs. In p-GaAs the Fermi level induced reduction of the defect formation energy is much smaller, and therefore the concentration of the native defects is negligible compared with the hole concentration. DOE

N90-18297# Oak Ridge National Lab., TN. Solid State Div.
SIMULATION AND QUANTIFICATION OF HIGH-RESOLUTION Z-CONTRAST IMAGING OF SEMICONDUCTOR INTERFACES
D. E. Jesson, S. J. Pennycook, and M. F. Chisholm Jan. 1990 8 p Presented at the Materials Research Society Fall Meeting, Boston, MA, 27 Nov. - 2 Dec. 1989 Submitted for publication
(Contract DE-AC05-84OR-21400)
(DE90-006159; CONF-891119-80) Avail: NTIS HC A02/MF A01

Incoherent characteristics of Z-contrast STEM images are explained using a Bloch wave approach. To a good approximation, the image is given by the columnar high angle cross section multiplied by the s-state intensity at the projected atom sites, convoluted with an appropriate resolution function. Consequently, image interpretation can be performed intuitively and quantitative simulation can be implemented on a small computer. The feasibility of column-by-column compositional mapping is discussed. DOE

N90-18298# Yale Univ., New Haven, CT. Dept. of Computer Science.
DISCRETIZATION OF THE STEADY STATE SEMICONDUCTOR DEVICE EQUATIONS
I. Efrat Sep. 1989 11 p
(Contract N00014-86-J-1906)
(AD-A215807; YALEU/DCS/RR-745) Avail: NTIS HC A03/MF A01 CSCL 09/1

The continuity equations of the drift-diffusion semiconductor device model are hard to discretize because of the severe variations of variables. The Scherfetter - Gummel scheme applies harmonic averages to the conductance function, and usually produces acceptable solutions despite the sharp parameter changes. Some authors attribute the success of this scheme to the relative smoothness of the currents, as compared with carrier concentrations. In this report it is shown that current smoothness cannot be derived from the differential equations, but is related to the specific boundary condition configuration. The success of the Scherfetter-Gummel method is hence easy to justify for nearly 1-D devices, but is harder to justify for some other geometries. A stream function formulation related to the scheme is shown to overcome cases where the continuity equations are ill-conditioned. GRA

N90-18299# Harry Diamond Labs., Adelphi, MD.
AN OVERVIEW OF RADIATION-INDUCED INTERFACE TRAPS IN MOS (METAL-OXIDE SEMICONDUCTOR) STRUCTURES Final Report, 1974 - 1988
Timothy R. Oldham, F. Barry McLean, H. Edwin Boesch, Jr., and James M. McGarrity Nov. 1989 37 p Sponsored by Army Lab. Command, Adelphi, MD
(HDL Proj. AE1923)
(AD-A216101; HDL-TR-2163) Avail: NTIS HC A03/MF A01 CSCL 20/12

We focus on radiation-induced interface traps, describing first how they fit into the overall radiation response of metal-oxide semiconductor (MOS) structures. Detailed measurements of the time-, field-, and temperature-dependences of the buildup of radiation-induced interface traps indicate three processes by which the buildup occurs. The largest of these is the slow two-stage process described by McLean and coworkers, which is rate limited by the hopping transport of hydrogen ions. Two other faster processes also contribute small interface trap buildups in gate oxides. The processes seem to be controlled by hole transport to the Si/SiO2 interface and by neutral hydrogen diffusion, respectively. We also discuss several models which fall into three classes, corresponding roughly to the three processes observed experimentally. Other topics discussed briefly are dose dependence, field oxide effects, chemical and processing dependences, and scaling effects. GRA

N90-18300# Department of the Navy, Washington, DC.
VOLATILE DIVALENT DOUBLE METAL ALKOXIDES Patent Application
Andrew Purdy, inventor (to Navy) 31 Jul. 1989 17 p
(AD-D014355; US-Patent-Appl-SN-387047) Avail: NTIS HC A02/MF A01 CSCL 07/3

The invention relates to volatile mixed metal alkoxides of the formula M'(X)M(Y)Cu(z) (OR) x+2(y+z) wherein M is selected from the group consisting of Ba, Sr, and Ca, M' is an alkali metal, x= 0-6, y= 0- 4 and z= 1 to 6, and x and y are not 0 at the same time, and R is selected from the group consisting of CMe3, CMe(2)Et, CMeEt(2), CMe(2)Pr, CMeEtPr, CEt(3) or combinations of these substituents. Volatile alkoxides of Y and Cu are known. These volatile alkoxides can be used in a CVD process where stoichiometric quantities of the material are sublimated, transported to a substrate and decomposed to an oxide with or without the presence of oxygen. The oxides are then treated in a known manner to produce the superconducting film. GRA

N90-18301# North Carolina Univ., Chapel Hill. Dept. of Physics and Astronomy.
MATERIALS PROCESSING OF DIAMOND: ETCHING, DOPING BY ION IMPLANTATION AND CONTACT FORMATION Annual Technical Report, 1 Oct. 1988 - 30 Sep. 1989
Max L. Swanson 30 Sep. 1989 46 p
(Contract N00014-87-K-0243)
(AD-A216530) Avail: NTIS HC A03/MF A01 CSCL 20/12

We are studying implantation doping, etching, contact formation, and regrowth of natural diamond, for future applications to the fabrication of devices from thin film chemical vapor deposition (CVD) diamond. In addition, we are characterizing thin film diamonds of other ONR contractors, using ion beam methods. In diamond, implantation doping is difficult because the high annealing temperature necessary to remove damage and to obtain efficient dopant activation often causes graphitization. We have used an innovative co-implantation of C plus the desired dopant at 77 K, followed by rapid thermal annealing (RTA) or furnace annealing, to overcome this problem. The removal of surface layers of diamond by polishing or chemical etching is hampered by its extreme hardness and chemical inertness. We have demonstrated that reactive ion etching with O is an effective method of removing controlled amounts of diamond. We have developed a new sputtering method of forming strong metallic contacts to diamond at ambient temperatures, which may prove invaluable for microelectronics and heat sink applications. Factors affecting epitaxial regrowth of damaged natural diamond are crucial for both ion beam doping and CVD growth. We have successfully regrown C-ion implanted natural diamond layers by RTA or furnace anneals. GRA

N90-18302# Lawrence Livermore National Lab., CA.
HIGH PERFORMANCE, PICOSECOND RADIATION DETECTORS GROWN BY MOLECULAR BEAM EPITAXY FOR MILLIMETER-WAVE DIAGNOSTIC SYSTEMS
Jeffrey D. Morse and Raymond P. Mariella, Jr. 1990 6 p Presented at the Department of Defense Fiber Optics Conference, McLean, VA, 20-23 Mar. 1990
(Contract W-7405-eng-48)
(DE90-005547; UCRL-102093; CONF-900333-4) Avail: NTIS HC A02/MF A01

GaAs layers grown by molecular beam epitaxy (MBE) at reduced substrate temperatures have been demonstrated to have excellent properties as picosecond photoconductive devices. Results will be presented demonstrating the superior performance of this technology in comparison to picosecond photoconductors fabricated from other materials, along with a discussion of its application to millimeter wave bandwidth photonic diagnostics systems. DOE

N90-17896*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
TEMPERATURE PROFILES IN HIGH GRADIENT FURNACES
A. L. Fripp, W. J. Debnam, G. A. Woodell, R. Berry, R. K. Crouch, and S. K. Sorokach (Planning Research Corp., Hampton, VA.) *In* JPL, Proceedings of the Second Noncontact Temperature Measurement Workshop 1 Jun. 1989 p 11-18 (For primary document see N90-17894 10-31)
Avail: NTIS HC A16/MF A03 CSCL 20L

N90-17910*# Massachusetts Inst. of Tech., Cambridge.
USE OF ANOMOLOUS THERMAL IMAGING EFFECTS FOR MULTI-MODE SYSTEMS CONTROL DURING CRYSTAL GROWTH
Michael J. Wargo *In* JPL, Proceedings of the Second Noncontact Temperature Measurement Workshop 1 Jun. 1989 p 158-167 (For primary document see N90-17894 10-31)
Avail: NTIS HC A16/MF A03 CSCL 20L

N90-17911*# North Carolina State Univ., Raleigh. Dept. of Materials Science and Engineering
COMMENTS ON CONTAINERLESS BULK CRYSTAL GROWTH AND EPITAXY IN SPACE AND ON THEIR IMPLICATIONS REGARDING NON-CONTACT TEMPERATURE MEASUREMENTS
Klaus J. Bachmann *In* JPL, Proceedings of the Second Noncontact Temperature Measurement Workshop 1 Jun. 1989 p 171-182 (For primary document see N90-17894 10-31)
Avail: NTIS HC A16/MF A03 CSCL 20L

N90-17914*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
TEMPERATURE CONTROL AND CALIBRATION ISSUES IN THE GROWTH, PROCESSING AND CHARACTERIZATION OF ELECTRONIC MATERIALS
B. A. Wilson *In its* Proceedings of the Second Noncontact Temperature Measurement Workshop 1 Jun. 1989 p 210-216 (For primary document see N90-17894 10-31)
Avail: NTIS HC A16/MF A03 CSCL 20L

N90-17915*# Bell Telephone Labs., Inc., Murray Hill, NJ.
FLUX LATTICE MELTING IN THE HIGH Tc SUPERCONDUCTORS
D. J. Bishop, P. L. Gammel, and L. F. Schneemeyer *In* JPL, Proceedings of the Second Noncontact Temperature Measurement Workshop 1 Jun. 1989 p 217-219 (For primary document see N90-17894 10-31)
Avail: NTIS HC A16/MF A03 CSCL 20L

77 THERMODYNAMICS AND STATISTICAL PHYSICS

Includes quantum mechanics; theoretical physics; and Bose and Fermi statistics.

For related information see also *25 Inorganic and Physical Chemistry* and *34 Fluid Mechanics and Heat Transfer.*

N90-18303# Geological Survey, Reston, VA.
MULTIVARIATE CLUSTERING BASED ON ENTROPY
J. M. Botbol 1989 39 p
(PB89-233993; USGS-Bull-1893; LC-89-600183) Avail: NTIS HC A03/MF A01 CSCL 20M

The results are presented of a study undertaken to develop a technique for assessing the information content between pairs of variables so that their interrelations can be assessed for subsequent multivariate analysis. The primary inputs to this procedure are scatter plots of all pairs of variables. These are considered as order-disorder information diagrams, and entropy, as used in information theory, is the major metric used to describe relations between the variables in the diagrams. Bivariate scatter plots of the sample depth and concentrations of 9 elements within 1,200 ferromanganese nodules of the northern Pacific Ocean were classified into two-day contingency tables. Entropy attributes were computed for each table. To the extent of this study, entropy proved effective in describing degrees of association between variables in chemical analyses. Similar studies can be used as effective tools in the multivariate analysis of geochemical data.
Author

N90-18304 Texas Univ., Austin.
SIMPLICIAL LATTICES IN CLASSICAL AND QUANTUM GRAVITY: MATHEMATICAL STRUCTURE AND APPLICATION Ph.D. Thesis
Norman Joseph LaFave 1989 250 p
Avail: Univ. Microfilms Order No. DA8920759

Geometrodynamics can be understood more clearly in the language of geometry than in the language of differential equations. This is the primary motivation for the development of calculational schemes based on Regge Calculus as an alternative to those schemes based on Ricci Calculus. The mathematics of simplicial lattices were developed to the same level of sophistication as the mathematics of pseudo--Riemannian geometry for continuum manifolds. This involves the definition of the simplicial analogues of several concepts from differential topology and differential geometry-the concept of a point, tangent spaces, forms, tensors, parallel transport, covariant derivatives, connections, and curvature. These simplicial analogues are used to define the Einstein tensor and the extrinsic curvature on a simplicial geometry. This mathematical formalism was applied to the solution of several outstanding problems in the development of a Regge Calculus based computational scheme for general geometrodynamic problems. This scheme is based on a 3 + 1 splitting of spacetime within the Regge Calculus prescription known as Null-Strut Calculus (NSC). NSC describes the foliation of spacetime into spacelike hypersurfaces built of tetrahedra. These hypersurfaces are coupled by light rays (null struts) to past and future momentum-like structures, geometrically dual to the tetrahedral lattice of the hypersurface. Avenues of investigation for NSC in quantum gravity are described. Dissert. Abstr.

N90-18305# International Centre for Theoretical Physics, Trieste (Italy).
N=2 SUPERGRAVITY IN SUPERSPACE AND THE BRS SYMMETRY
M. Kachkachi and T. Lhallabi Jul. 1989 16 p Submitted for publication
(DE90-607062; IC-89/185) Avail: NTIS (US Sales Only) HC A03/MF A01

The quantum N = 2 Einstein supergravity action is constructed by requiring the BRS symmetry. This latter is derived by the use of the distorted horizontality conditions in the curved N = 2 harmonic superspace. DOE

N90-18306# International Centre for Theoretical Physics, Trieste (Italy).
SOLUTION OF A CLASS OF CONFORMAL QUANTUM FIELD THEORY MODELS IN D-DIMENSIONAL SPACE
E. S. Fradkin and M. Ya. Palchik (Institute of Automation and Electrometry, Novosibirsk, USSR) Jul. 1989 26 p Submitted for publication
(DE90-607094; IC-89/168) Avail: NTIS (US Sales Only) HC A03/MF A01

Proposed is a method of solving a class of conformal quantum field theory models in D-dimensional Euclidean space-time. Some of the models are determined by regularized field equations. The method allows closed differential equations to be obtained for each Green function of fundamental and composite fields, and also algebraic equations for scale dimensions of fields. Each D is greater than 2-model involves an analog of the central charge, i.e., a special scalar field P of dimension d(sub p)=D-2. When D=2 this field turns into a constant. A new class of D=2 models was also obtained with broken infinite parameter symmetry. Closed differential equation for Green functions of these models are found. As an illustration of how the method works, solutions of the Thirring

and Wess-Zumino-Witten models and the two-dimensional Ising model were derived. DOE

N90-18307# Hiroshima Univ., Takehara (Japan). Research Inst. for Theoretical Physics.
BRS CURRENT AND RELATED ANOMALIES IN TWO-DIMENSIONAL GRAVITY AND STRING THEORIES
Kazuo Fujikawa, Takeshi Inagaki, and Hiroshi Suzuki Jun. 1989 38 p
(DE90-733095; RRK-89-17) Avail: NTIS (US Sales Only) HC A03/MF A01

The BRS currents in two-dimensional gravity and supergravity theories, which are related to string theory, contain anomalous terms. The origin of these anomalies can be neatly understood in a carefully defined path integral. The detailed calculations of these BRS and related anomalies are presented in the holomorphic or antiholomorphic sector separately in the conformal gauge. One-loop renormalization of the Liouville action becomes transparent in the formulation. A BRS-invariant BRS current (and thus nil-potent charge) and a conformally invariant ghost number current were identified by incorporating the dynamical Weyl freedom explicitly. The formal path integral construction of various composite operators is also checked by using the operator product technique. Implications of these BRS analyses on possible non-critical string theories at d is less than 26 or d is less than 10 are briefly discussed. DOE

N90-18308# Arizona Univ., Tucson. Dept. of Physics.
SCALE TRANSFORMATIONS, THE ENERGY-MOMENTUM TENSOR, AND THE EQUATION OF STATE
P. Carruthers 1989 9 p Presented at the NATO Advanced Study Institute International Advanced Course on the Nuclear Equation of State, Peniscola (Spain), 21 May - 3 Jun. 1989
(Contract DE-FG02-88ER-40452)
(DE90-005372; CONF-8905143-21; AZPH-TH/89-52) Avail: NTIS HC A02/MF A01

The Equation of State (EOS) relates diagonal elements of the energy momentum tensor theta muons. The first moment of the energy momentum tensor generates scale transformations. The virial theorem, a consequence of the behavior of the energy density under scale transformations, allows one to eliminate the kinetic energy in terms of the potential terms. The trace theorem for the energy momentum tensor expresses (epsilon)-3p in terms of ensemble averages of scale-breaking operators, allowing a new approach to the EOS. DOE

N90-18309# Minnesota Univ., Minneapolis. School of Physics and Astronomy.
RESEARCH IN THEORETICAL NUCLEAR PHYSICS
1990 15 p
(Contract DE-FG02-87ER-40328)
(DE90-006063; DOE/ER-40328/88) Avail: NTIS HC A03/MF A01

Research programs in nuclear theory are discussed. The topics discussed are: neutron stars and pulsars; transverse momentum distribution; intermittency and other correlations; photon and delepton production; electroweak theory at high temperature; and fractional statistics. DOE

80 SOCIAL SCIENCES (GENERAL)

Includes educational matters.

N90-18310# Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil). Ministerio de Ciencia e Tecnologia.
THE EMPLOYMENT OF SITIM-150 AS AN INSTRUCTIONAL OBJECTIVE FOR TRAINING IN REMOTE SENSING
Maria deLourdesNevesdeOliveiraKurkdjian, Adriana Abrahao, Eliana Miglioranza, and Jose Carlos Moreira Jun. 1989 7 p In PORTUGUESE; ENGLISH summary Presented at the 5th Brazilian Symposium on Remote Sensing, Natal, Brazil, 11-15 Oct. 1988
(INPE-4833-PRE/1463) Avail: NTIS HC A02/MF A01

The application of an education technology model for planning and designing of instructional systems envolves some basic concepts, one of them related to the selection of appropriate communication media. This approach recognizes the use of multimedia. In this case, a set of media instead of a single one, is selected to transmit the instruction. The radio, television, tape recorder, computer, book, among other communication media, were already used for this purpose. The objective is to examine the utility of using the digital image analyzer system - SITIM-150 as a communication media in remote sensing training courses. In order to attain this objective an instructional material related to the use of TM/LANDSAT data for urban studies was produced, to be held on the SITIM-150. In this process the instructional objectives of the lecture were identified, the contents to be taught were specified, and then a programmed instruction was produced and implemented in the system. For this implementation both elements of the SITIM-150 were used: the image visualizer unit and the microcomputer. The final product was considered appropriate for the purpose viewed by the test. This is due to its propriety to simultaneously display the verbal and pictorial information required to attain the instructional objectives, related to the interpretation of orbital remote sensing data. Author

81 ADMINISTRATION AND MANAGEMENT

Includes management planning and research.

N90-18311# Department of Energy, Washington, DC. Office of Industrial Programs.
OFFICE OF INDUSTRIAL PROGRAMS RESEARCH IN PROGRESS
Dec. 1989 42 p Prepared in cooperation with DOE Office of Scientific and Technical Information, Oak Ridge, TN
(DE90-002100; DOE/OSTI-11633-2) Avail: NTIS HC A03/MF A01

The U.S. Department of Energy Office of Industrial Programs conducts industrial energy conservation research and development activities. These activities are focused on achieving the objectives of improving energy use efficiency and providing for fuel flexibility within U.S. industry. To accomplish these objectives the Office has adopted the basic strategy of identifying, in cooperation with private industry the technological needs for energy conservation in the industrial sector; identifying what private industry is currently doing or will not do alone; selecting the highest priority targets not being pursued by the private sector; and negotiating cost-shared contracts with private industry, or contracts with universities and government laboratories to carry out the necessary research. Research is developed to the point that the new technology has been proven to work and sufficient proof can be disseminated to the private sector end users. To date, the Office of Industrial Programs has supported over two hundred research and development projects covering a wide spectrum of industrial applications -- both generic conservation technologies and energy intensive processes unique to specific industries. DOE

N90-18312# Air Force Human Resources Lab., Brooks AFB, TX.
TOTAL QUALITY MANAGEMENT: AN APPLICATION IN A RESEARCH AND DEVELOPMENT LABORATORY Final Technical Paper Dec. 1988 - Sep. 1989
Herbert J. Clark Dec. 1989 22 p
(AD-A215808; AFHRL-TP-89-58) Avail: NTIS HC A03/MF A01 CSCL 05/1

In September 1988, the Air Force Human Resources Laboratory (AFHRL) took initial steps to set up a Total Quality Management (TQM) program in the Laboratory. The implementation procedure used was the Method for Generating Efficiency and Effectiveness Measures (MGEEM). This procedure focuses on satisfying customer requirements, identifying Key Result Areas (KRAs) and tracking

progress in those KRAs through Mission Effectiveness Indicators. This report outlines how TQM was implemented in AFHRL, and describes the lessons learned in the process. Lessons learned address: TQM versus Total Quality Control (TQC), applying TQM in an R and D organization, sustaining TQM, process action teams, and the acceptance of MGEEM as a method for implementing TQM. The survey feedback intervention technique, the confrontation meeting, and work teams are recommended for establishing TQM in an R and D organization. The procedures allow both managers and workers to develop a sense of ownership in the TQM process. This in turn increases the likelihood of sustaining the program and insuring its long-term effectiveness. GRA

82 DOCUMENTATION AND INFORMATION SCIENCE

Includes information management; information storage and retrieval technology; technical writing; graphic arts; and micrography.

For computer documentation see *61 Computer Programming and Software.*

N90-18313 Texas Univ., Austin.
THE DESIGN AND ANALYSIS OF ALGORITHM AND DATA STRUCTURE FOR EFFICIENT SOLUTIONS OF MINIMUM-COST NETWORK FLOW PROBLEMS ON MISD AND MIMD Ph.D. Thesis
Shan-Hui Ho 1988 203 p
Avail: Univ. Microfilms Order No. DA8909671

The network structures of a simplex code were improved to contain a network model structure, a two-stage search tree for a pricing system, and a basis structure. The network model structure is associated with a set of list functions. The structure of a pricing system is proposed as an intelligent two-stage search tree by employing an artificial intelligence (AI) search method. A preparation stage uses different sorting methods to select the most eligible arcs from the candidate list. Then the second stage, a branching stage, uses one of the arcs to do a pivot on a basis structure. This basis structure can be built as a spanning tree by a set of the ATR calculations. Because this code applies a specialized design to network structures and an AI method to the pricing rule, it is one of the fastest codes to date. The relaxation-plus method presented employs a newly invented AI search method to enumerate a dynamic two-stage search tree to provide the most eligible node with the highest estimated deficit and then process that node through the dual gradient method. Dissert. Abstr.

N90-18314 California Univ., Berkeley.
THE DESIGN AND ANALYSIS OF NEW TECHNIQUES FOR TRANSACTION MANAGEMENT IN DATABASE SYSTEMS Ph.D. Thesis
Akhil Kumar 1988 177 p
Avail: Univ. Microfilms Order No. DA8916743

New techniques are devised and evaluated for transaction management in centralized and distributed database systems. A detailed study to assess the feasibility of an operating system transaction manager was carried out. The results of these experiments indicate that the operating system typically incurs a 30 percent performance penalty as compared to a conventional database system, primarily because the database system possesses much greater semantic knowledge about the processing environment. Various ways of enhancing the operating system performance are examined. These improvements are in the nature of semantic features that attempt to overcome some of the operating system disadvantages. New algorithms for multi-copy concurrency control are described. These algorithms are based on a new property called multi-copy commutativity and they speed up transaction processing significantly in situations where a large percentage of the transactions are commutative. A different approach to reducing transaction overhead in a replicated data environment is examined. It is shown that by suitable assigning votes to sites based on unit inter-site communications costs, traffic volumes and reliability of each site, sizable reductions in the total communications cost are possible. Dissert. Abstr.

N90-18315 Louisiana State Univ., Baton Rouge.
A HYBRID MODEL FOR DOCUMENT RETRIEVAL SYSTEMS Ph.D. Thesis
Zhen-Bao Zou 1988 149 p
Avail: Univ. Microfilms Order No. DA8917873

A methodology for the design of document retrieval systems is presented. First, a composite index term weighting model is developed based on term frequency statistics, including document frequency, relative frequency within document and relative frequency within collection, which can be adjusted by selecting various coefficients to fit into different indexing environments. Then, a composite retrieval model is proposed to process a user's information request in a weighted Phrase-Oriented Fixed-Level Expression (POFLE), which may apply more than Boolean operators, through two phases. That is, a search is presented for documents which are topically relevant to the information request by means of a descriptor matching mechanism, which incorporate a partial matching facility based on a structurally restricted relationship imposed by indexing model, and is more general than matching functions of the traditional Boolean model and vector space model, and a ranking is presented of these topically relevant documents, by means of two types of heuristic-based selection rules and a knowledge-based evaluation function, in descending order of a preference score which predicts the combined effect of user preference for quality, recency, fitness and reachability of documents. Dissert. Abstr.

N90-18316# Sandia National Labs., Albuquerque, NM.
PHOTOCHROMIC PAPERS OR FILMS FOR NONCOPYABLE DOCUMENTS
Mar. 1989 17 p Transl. into ENGLISH of Japanese Patent No. 8553981
(Contract DE-AC04-76DP-00789)
(DE90-004006; ALS/TR-89-09) Avail: NTIS HC A03/MF A01

This invention, is related to a paper film for a document in which (the writing) disappears and reappears due to irradiation by a light source and which is made so that, when copying a book or document, at the time of placing it in the copy machine, due to irradiation by its light source, a light sensitive, or so called photochromic light sensitive ink, prints in the surface vicinity of the already printed letters, pictures, and images; or, this printed transparent film is caused to be positioned and affixed to the front face; or lastly, by means of constructing a paper or plastic film which has laminated on it a light blocking film, at the time of copying, a light sensitive surface which makes it difficult to read the already printed letters, pictures, images and such is caused to be formed and erased, and by means of interrupting the light for a fixed time by means of a dark place or a filter, this light sensitive surface is erased and deciphering can be done. DOE

N90-18317* National Aeronautics and Space Administration, Washington, DC.
NASA PATENT ABSTRACTS BIBLIOGRAPHY: A CONTINUING BIBLIOGRAPHY. SECTION 2: INDEXES (SUPPLEMENT 36)
Jan. 1990 516 p
(NASA-SP-7039(36)-Sect-2; NAS 1.21:7039(36)-Sect-2) Avail: NTIS HC A22; NTIS standing order as PB89-911100, $29.00 domestic, $58.00 foreign CSCL 05B

A subject index is provided for over 4600 patents and patent applications for the period May 1969 through December 1989. Additional indexes list personal authors, corporate authors, contract numbers, NASA case numbers, U.S. patent class numbers, U.S. patent numbers, and NASA accession numbers. Author

N90-18318 California Inst. of Tech., Pasadena.
BINARY CORRELATORS FOR OPTICAL COMPUTING AND PATTERN RECOGNITION Ph.D. Thesis
Fai Ho Mok 1989 216 p
Avail: Univ. Microfilms Order No. DA9000584

The matrix-vector multiplier is an important building block in optical information processing architectures, examples of which are correlators for pattern recognition, associative memories, and neural networks. Such architectures are most suitable for implementation by optics due to the ease in realizing dense interconnections optically. The success of the implementation partially relies on the quality of the SLM used to record the information for processing. Limited dynamic range for the representation of the data recorded is a common drawback suffered by most commercially available devices. The importance of the dynamic range of the device on the performance of the implementation is investigated. The effect of limited dynamic range on the signal to noise ratio, probability of error, capacity, and training of various forms of matrix-vector multipliers are addressed. Through the use of theoretical analyses, computer simulations, and optical experiments, it will be shown that a large dynamic range is not essential in most applications. Specifically, it is shown that only one bit of dynamic range, i.e., two gray levels, for the representation of each data point, results in acceptable loss in performance. Dissert. Abstr.

N90-18319# Defense Technical Information Center, Alexandria, VA.
SOURCE HEADER LIST. VOLUME 1: A THROUGH K Annual Report, Jun. 1988 - Nov. 1989
Loretta M. Brown, comp. Dec. 1989 556 p
(AD-A216000; DTIC/TR/89/21-Vol-1) Avail: NTIS HC A24/MF A03 CSCL 05/2

This publication is the first of two volumes of an alphabetically arranged compilation of corporate author names used by the Defence Technical Information Center in the DTIC database system. Each source name is assigned a 6-digit numeric code for computer input and retrieval purpose plus a 4-digit alphanumeric geopolitical code and an alphanumeric type code. Source names displayed are included as data elements in the Technical Report, Work Unit Information System and Independent Research and Development databases maintained by DTIC. GRA

N90-18320# Defense Technical Information Center, Alexandria, VA.
SOURCE HEADER LIST. VOLUME 2: L THROUGH Z Annual Report, Jun. 1988 - Nov. 1989
Loretta M. Brown, comp. Dec. 1989 560 p
(AD-A216001; DTIC/TR/89/21-Vol-2) Avail: NTIS HC A24/MF A03 CSCL 05/2

This publication is the second of two volumes of an alphabetically arranged compilation of corporation author names used by the Defense Technical Information Center in the DTIC database system. Each source name is assigned a 6-digit numeric code for computer input and retrieval purpose plus a 4-digit alphanumeric geopolitical code and an alphanumeric type code. Source names displayed are included as data elements in the Technical Report, Work Unit Information System and Independent Research and Development database maintained by DTIC. GRA

N90-18321# Defense Technical Information Center, Alexandria, VA.
SOURCE HIERARCHY LIST. VOLUME 1: A THROUGH D Annual Report, Jan. 1988 - Nov. 1989
Claudine S. Long Dec. 1989 839 p Supersedes DTIC/TR-88/10-Vol-1
(AD-A216050; DTIC/TR-89/22-Vol-1; DTIC/TR-88/10-Vol-1)
Avail: NTIS HC A99/MF A02 CSCL 05/2

This is the second of three volumes of an alphabetical listing of corporate authors as used for announcement of reports received in the Defense Technical Information Center (DTIC). Former names of organizations are included and displayed below the current source name used by DTIC. Cross references direct the user from sub-element organizations to the major source level entry where they are also displayed. Major and sub-hierarchies are preceded and ended by a row of asterisks. This list is used in conjunction with and is not a replacement for DTIC's Source Header List, Volume 1, AD-A216000, and Volume 2, AD-A216001. It displays only those source names from the Source Header List for which hierarchical linkages are pertinent. GRA

N90-18322# Defense Technical Information Center, Alexandria, VA.
SOURCE HIERARCHY LIST. VOLUME 2: E THROUGH N Annual Report, Jan. 1988 - Nov. 1989
Claudine S. Long Dec. 1989 750 p Supersedes DTIC/TR-88/10-Vol-2
(AD-A216051; DTIC/TR-89/22-Vol-2; DTIC/TR-88/10-Vol-2)
Avail: NTIS HC A99/MF A02 CSCL 05/2

This is the second of three volumes of an alphabetical listing of corporate authors as used for announcement of reports received in the Defense Technical Information Center (DTIC). Former names of organizations are included and displayed below the current source name used by DTIC. Cross referenced direct the user from sub-element organizations to the major source level entry where they are also displayed. major and sub-hierarchies are preceded and ended by a row of asterisks. This list is used in conjunction with and is not a replacement for DTIC's Source Header List, Volume 1, AD-A216000, and Volume 2, AD-A216001. It displays only those source names from the Source Header List for which hierarchical linkages are pertinent. GRA

N90-18323# Defense Technical Information Center, Alexandria, VA.
SOURCE HIERARCHY LIST. VOLUME 3: O THROUGH Z Annual Report, Jan. 1988 - Nov. 1989
Claudine S. Long Dec. 1989 677 p Supersedes DTIC/TR-88/10-Vol-3
(AD-A216052; DTIC/TR-89/22-Vol-3; DTIC/TR-88/10-Vol-3)
Avail: NTIS HC A99/MF A04 CSCL 05/2

This is the second of three volumes of an alphabetical listing of corporate authors as used for announcement of reports received in the Defense Technical Information Center (DTIC). Former names of organizations are included and displayed below the current source name used by DTIC. Cross references direct the user from sub-element organizations to the major source level entry where they are also displayed. Major and sub-hierarchies are preceded and ended by a row of asterisks. This list is used in conjunction with and is not a replacement for DTIC's Source Header List, Volume 1, AD-A216000, and Volume 2, AD-A216001. It displays only those source names from the Source Header List for which hierarchical linkages are pertinent. GRA

N90-18324# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Systems and Logistics.
AN ANALYSIS OF THE IMPACTS OF COMPUTER-BASED INFORMATION SYSTEMS ON RESEARCH AND DEVELOPMENT ORGANIZATIONS M.S. Thesis
George H. Sarmiento Sep. 1989 121 p
(AD-A216283; AFIT/GSM/LSY/89S-33) Avail: NTIS HC A06/MF A01 CSCL 12/7

Today, more and more organizations are turning towards computer based information systems to help them deal with the complexities brought on by the Information Society. These computer based information systems are impacting all levels of the organizations. This research effort was a study involving the impact of a computer based information system at a USAF research and development organization. A key aspect of the study was to attempt to identify if any demographic groups perceived themselves to be impacted by the CBIS more than others. The results show that a CBIS was perceived by the respondents to impact organizational communication and organization tasks. Communication within sub-units, between sub-units, and throughout the organization were perceived to be enhanced. In addition, the findings indicate that those members willing to use the system perceived a positive impact on task efficiency and task coordination. Interestingly, the respondents reported that the information system had not reduced their task workload. However, the findings show that the impacts to the organizational hierarchy were mixed. GRA

N90-17919*# Purdue Univ., West Lafayette, IN. Center for Information and Numerical Data Analysis and Synthesis.
MATERIALS PROPERTIES NUMERICAL DATABASE SYSTEM ESTABLISHED AND OPERATIONAL AT CINDAS/PURDUE UNIVERSITY
C. Y. Ho and H. H. Li *In* JPL, Proceedings of the Second Noncontact Temperature Measurement Workshop 1 Jun. 1989 p 236-250 (For primary document see N90-17894 10-31)
Avail: NTIS HC A16/MF A03 CSCL 05B

N90-17946*# Colorado Univ., Boulder. Dept. of Electrical and Computer Engineering.
NASA PROPAGATION INFORMATION CENTER
Ernest K. Smith and Warren L. Flock *In* JPL, Proceedings of the 13th NASA Propagation Experimenters Meeting (NAPEX 13) 15 Aug. 1989 p 10-13 (For primary document see N90-17945 10-32)
Avail: NTIS HC A11/MF A02 CSCL 05B

83 ECONOMICS AND COST ANALYSIS

Includes cost effectiveness studies.

No abstracts in this category.

84 LAW, POLITICAL SCIENCE AND SPACE POLICY

Includes NASA appropriation hearings; aviation law; space law and policy; international law; international cooperation; and patent policy.

No abstracts in this category.

85 URBAN TECHNOLOGY AND TRANSPORTATION

Includes applications of space technology to urban problems; technology transfer; technology assessment; and surface and mass transportation.

For related information see also *03 Air Transportation and Safety, 16 Space Transportation,* and *44 Energy Production and Conversion.*

N90-18325# Chapman Research Group, Inc., Littleton, CO.
AN EXPLORATION OF BENEFITS FROM NASA SPINOFF
Richard L. Chapman, Loretta C. Lohman, and Marilyn J. Chapman Jun. 1989 66 p
(Contract NERAC-88-01)
Avail: NTIS HC A04/MF A01

A retrospective analysis of the applications of NASA technology reported in the annual publication Spinoff was conducted. The primary objective of the study was to identify and, where possible, quantify the benefits resulting from those applications. Interviews were conducted with various contacts from companies, institutions, and agencies mentioned in Spinoff articles or included in Spinoff files. Approximately 600 useful interviews from 400 companies were obtained. The results revealed six principle avenues by which NASA facilitates the transfer of technology of practical utilization and commercialization. Those avenues included: direct use of NASA technology, creation of markets, facilitation of commercial acceptance, assistance through NASA-sponsored Industrial Applications Centers, transfer of NASA employees, spinoff to other public agencies, and spinoffs from regular NASA R and D activities. Estimates of sales and savings benefits realized from NASA technology are presented for nine general categories of end use. Other non-quantifiable benefits are also discussed including: extension of knowledge and technologies of a critical or valuable nature; identification of new opportunities; helping companies increase their competitiveness; safety, regulatory, and quality-of-life improvements; and helping companies to avoid R and D dead-ends. M.G.

N90-18326*# Martini Engineering, Richland, WA.
DEVELOPMENT OF FREE-PISTON STIRLING ENGINE PERFORMANCE AND OPTIMIZATION CODES BASED ON MARTINI SIMULATION TECHNIQUE
William R. Martini Sep. 1989 269 p
(Contract NAS3-22256)
(NASA-CR-182210; NAS 1.26:182210) Avail: NTIS HC A12/MF A02 CSCL 10B

A FORTRAN computer code is described that could be used to design and optimize a free-displacer, free-piston Stirling engine similar to the RE-1000 engine made by Sunpower. The code contains options for specifying displacer and power piston motion or for allowing these motions to be calculated by a force balance. The engine load may be a dashpot, inertial compressor, hydraulic pump or linear alternator. Cycle analysis may be done by isothermal analysis or adiabatic analysis. Adiabatic analysis may be done using the Martini moving gas node analysis or the Rios second-order Runge-Kutta analysis. Flow loss and heat loss equations are included. Graphical display of engine motions and pressures and temperatures are included. Programming for optimizing up to 15 independent dimensions is included. Sample performance results are shown for both specified and unconstrained piston motions; these results are shown as generated by each of the two Martini analyses. Two sample optimization searches are shown using specified piston motion isothermal analysis. One is for three adjustable input and one is for four. Also, two optimization searches for calculated piston motion are presented for three and for four adjustable inputs. The effect of leakage is evaluated. Suggestions for further work are given. Author

N90-18327# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Systems and Logistics.
TECHNOLOGY TRANSFER AND THE FSX: EFFECTS ON THE UNITED STATES/JAPANESE RELATIONSHIP M.S. Thesis
Peter C. Leahy Sep. 1989 93 p
(AD-A216348; AFIT/GCM/LSM/89S-8) Avail: NTIS HC A05/MF A01 CSCL 05/2

The purpose of this study was to examine the role that technology transfer assumes in the relationship between the U.S. and Japan. The objective of this is to determine if U.S. policy should look not only at the transfer of technology to help maintain its strategic interests with Japan but to see if U.S. economic interests should play a more significant part in the technology transfer decision. The study found that U.S. policy is broadening its focus so that military and economic interests are examined when transferring technology to Japan. The study found that the FSX agreement between the U.S. and Japan was one of the reasons for this shift in U.S. policy. GRA

N90-18328# Institute for Defense Analyses, Alexandria, VA.
THE USE OF TECHNOLOGY TRANSFER CENTERS BY DEPARTMENT OF DEFENSE INDUSTRIAL FACILITIES Final Report, Jan. - Apr. 1989
Paul H. Richanbach and Frederick R. Riddell Oct. 1989 24 p
(Contract MDA903-89-C-0003)
(AD-A216863; AD-E501184; IDA-P-2227; IDA/HQ-89-34262)
Avail: NTIS HC A03/MF A01 CSCL 05/2

One problem posed by the Navy's industrial facilities is that they do not have the resources to stay fully abreast of all of the new technologies or industrial processes of potential value to their facilities. This paper describes the attributes of various types of technology transfer centers in existence in the United States today, and provides a brief evaluation of which type of technology transfer

capability is most appropriate to the needs of the Navy's shipyards and aviation depots. The paper recommends that the Navy provide its industrial activities with access to technology transfer centers, and suggests a five-step plan for accomplishing this. GRA

88 SPACE SCIENCES (GENERAL)

N90-18329*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
SOLAR-TERRESTRIAL SCIENCE STRATEGY WORKSHOP
Peter M. Banks, ed., William T. Roberts, ed., and Jack Kropp, ed. (TRW, Inc., Redondo Beach, CA.) Washington Sep. 1989 73 p Workshop held in Stanford, CA, 12-16 Sep. 1988 Original contains color illustrations
(NASA-CP-3048; M-617; NAS 1.55:3048) Avail: NTIS HC A04/MF A01; 4 functional color pages CSCL 03B

The conclusions and recommendations reached at the Solar Terrestrial Science Strategy Workshop are summarized. The charter given to this diverse group was: (1) to establish the level of scientific understanding to be accomplished with the completion of the current and near term worldwide programs; (2) identify the significant scientific questions to be answered by future solar terrestrial programs, and the programs required to answer these questions; and (3) map out a program strategy, taking into consideration currently perceived space capabilities and constraints, to accomplish the identified program. For individual titles, see N90-18330 through N90-18338.

N90-18330*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
BACKGROUND OF THE WORKSHOP
In its Solar-Terrestrial Science Strategy Workshop Sep. 1989 p 1-4 (For primary document see N90-18329 10-88)
Avail: NTIS HC A04/MF A01; 4 functional color pages CSCL 03B

The long-term effects of the Challenger accident on solar-terrestrial science resulted in the need to examine the near-term missions under development for the next five years. The workshop was organized to seek ideas and opinions about the future of solar-terrestrial flight programs. Included are considerations of all types of space platforms, i.e., balloons, rockets, free flying satellites, and the variety of platforms supported by NASA astronauts. Specific issues include: the establishment of the level of understanding to be accomplished with the completion of the current worldwide program of research in solar-terrestrial sciences; the identification of major questions to be answered by the future solar-terrestrial sciences research program as it might be if initiated within the next ten years; the identification of space capabilities to be available to the future program and provision of input about the Space Physics Division's priorities for using these to accomplish its future scientific program; and mapping a program strategy to accomplish a future program of research in the solar-terrestrial sciences within the research community's perception of capabilities and constraints. B.G.

N90-18331*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
SUPPORTING TOOLS OF SOLAR-TERRESTRIAL SCIENCE
In its Solar-Terrestrial Science Strategy Workshop Sep. 1989 p 5-7 (For primary document see N90-18329 10-88)
Avail: NTIS HC A04/MF A01; 4 functional color pages CSCL 03B

Solar-terrestrial science is pursued by individuals and teams of workers situated in academia, research institutes, industry, and government laboratories. Progress in the field is made in various ways, but publication of results in scientific journals is the principal means of assuring that the knowledge gained from research is available to the public, now and in the future. In general, much of the research in the field is made via careful evaluation of data viewed in the context of fundamental physical principles as set forth in theoretical and analytical models, and computer simulations of physical processes. In addition, there is accumulation of knowledge expressed in the development of empirical or phenomenological models. Experience gained over the past three decades of solar-terrestrial research indicated that advances in the field require a diversity of resources and that the health of the entire discipline depends upon a balance among these. To maintain the health of the discipline, NASA and other federal funding agencies concerned with solar-terrestrial research must work together to insure that the following resources are available in reasonable measure to support solar-terrestrial research endeavors: ground-based facilities; balloons and rockets; spaceborne experiments; information networks; computational resources; models of solar terrestrial processes; data bases and archives; and research students. Author

N90-18332*# Michigan Univ., Ann Arbor.
REPORT FROM UPPER ATMOSPHERIC SCIENCE **c46**
G. R. Carignan, R. G. Roble, S. B. Mende (Lockheed Missiles and Space Co., Palo Alto, CA.), A. F. Nagy, and R. D. Hudson *In* NASA, Marshall Space Flight Center, Solar-Terrestrial Science Strategy Workshop Sep. 1989 p 9-13 (For primary document see N90-18329 10-88)
Avail: NTIS HC A04/MF A01; 4 functional color pages CSCL 04A

Most of the understanding of the thermosphere resulted from the analysis of data accrued through the Atmosphere Explorer satellites, the Dynamics Explorer 2 satellite, and observations from rockets, balloons, and ground based instruments. However, new questions were posed by the data that have not yet been answered. The mesosphere and lower thermosphere have been less thoroughly studied because of the difficulty of accessibility on a global scale, and many rather fundamental characteristics of these regions are not well understood. A wide variety of measurement platforms can be used to implement various parts of a measurement strategy, but the major thrusts of the International Solar Terrestrial Physics Program would require Explorer-class missions. A remote sensing mission to explore the mesosphere and lower thermosphere and one and two Explorer-type spacecraft to enable a mission into the thermosphere itself would provide the essential components of a productive program of exploration of this important region of the upper atomsphere. Theoretical mission options are explored. Author

N90-18333*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
REPORT FROM IONOSPHERIC SCIENCE **c46**
W. J. Raitt, Peter M. Banks, A. F. Nagy (Michigan Univ., Ann Arbor.), and C. R. Chappell *In its* Solar-Terrestrial Science Strategy Workshop Sep. 1989 p 15-23 (For primary document see N90-18329 10-88)
Avail: NTIS HC A04/MF A01; 4 functional color pages CSCL 04A

The general strategy to advance knowledge of the ionospheric component of the solar terrestrial system should consist of a three pronged attack on the problem. Ionospheric models should be refined by utilization of existing and new data bases. The data generated in the future should emphasize spatial and temporal gradients and their relation to other events in the solar terrestrial system. In parallel with the improvement in modeling, it will be necessary to initiate a program of advanced instrument development. In particular, emphasis should be placed on the area of improved imaging techniques. The third general activity to be supported should be active experiments related to a better understanding of the basic physics of interactions occurring in the ionospheric environment. These strategies are briefly discussed. Author

N90-18334*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
REPORT FROM MAGNETOSPHERIC SCIENCE **c46**
J. L. Burch, J. D. Winningham, H. R. Anderson, D. N. Baker, C. R. Chappell, and W. W. L. Taylor (TRW Defense and Space

Systems Group, Redondo Beach, CA.) *In its* Solar-Terrestrial Science Strategy Workshop Sep. 1989 p 25-30 Original contains color illustrations (For primary document see N90-18329 10-88)
Avail: NTIS HC A04/MF A01; 4 functional color pages CSCL 04A

By the early 1990s, magnetospheric physics will have progressed primarily through observations made from Explorer-class spacecraft, sounding rockets, ground based facilities, and shuttle based experiments. The global geospace science (GGS) element of the International Solar Terrestrial Physics program, when combined with contributions to the ESA Cluster mission and ground based and computer modeling programs, will form the basis for a major U.S. initiative in magnetospheric physics. The scientific objectives of the GGS program involve the study of energy transport throughout geospace. The Cluster mission will investigate turbulence and boundary phenomena in geospace, particularly at high latitudes on the dayside and in the region of the neutral sheet at geocentric distances of about 20 earth radii on the night side of the earth. The current state of knowledge is reviewed and the goals of these missions are briefly discussed. Author

N90-18335*# Stanford Univ., CA.
REPORT FROM SOLAR PHYSICS **c92**
A. B. C. Walker, L. Acton, G. Brueckner, E. L. Chupp, H. S. Hudson, and W. Roberts (San Jose State Univ., CA.) *In* NASA, Marshall Space Flight Center, Solar-Terrestrial Science Strategy Workshop Sep. 1989 p 31-49 Original contains color illustrations (For primary document see N90-18329 10-88)
Avail: NTIS HC A04/MF A01; 4 functional color pages CSCL 03B

A discussion of the nature of solar physics is followed by a brief review of recent advances in the field. These advances include: the first direct experimental confirmation of the central role played by thermonuclear processes in stars; the discovery that the 5-minute oscillations of the Sun are a global seismic phenomenon that can be used as a probe of the structure and dynamical behavior of the solar interior; the discovery that the solar magnetic field is subdivided into individual flux tubes with field strength exceeding 1000 gauss. Also covered was a science strategy for pure solar physics. Brief discussions are given of solar-terrestrial physics, solar/stellar relationships, and suggested space missions. R.J.F.

N90-18336*# Physical Sciences, Inc., Andover, MA.
REPORT FROM SPACE PLASMA SCIENCE **c75**
D. E. Hastings, A. Drobot, Peter M. Banks, W. W. L. Taylor, and H. R. Anderson (Rice Univ., Houston, TX.) *In* NASA, Marshall Space Flight Center, Solar-Terrestrial Science Strategy Workshop Sep. 1989 p 51-59 (For primary document see N90-18329 10-88)
Avail: NTIS HC A04/MF A01; 4 functional color pages CSCL 20I

Space plasma science, especially plasma experiments in space, is discussed. Computational simulations, wave generation and propagation, wave-particle interactions, charged particle acceleration, particle-particle interactions, radiation transport in dense plasmas, macroscopic plasma flow, plasma-magnetic field interactions, plasma-surface interactions, prospects for near-term plasma science experiments in space and three-dimensional plasma experiments are among the topics discussed. R.J.F.

N90-18337*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
MAJOR THEMES IN THE FUTURE OF SOLAR-TERRESTRIAL SCIENCE **c46**
In its Solar-Terrestrial Science Strategy Workshop Sep. 1989 p 61-64 (For primary document see N90-18329 10-88)
Avail: NTIS HC A04/MF A01; 4 functional color pages CSCL 04A

Various aspects of solar-terrestrial science are briefly discussed. The evolution of the concept of the Solar-Terrestrial Observatory (STO) is discussed. Several remote sensing concepts were proposed. The capability to image global atmospheric, ionospheric, and magnetospheric phenomena was thought to hold considerable promise for understanding global processes. All groups of the workshop expressed a desire to develop a means for focusing research activities on data acquired from past space missions. International cooperation, new vantage points for viewing the Earth and the Sun, Explorer-class satellites, Space Shuttle missions, and other astronaut-associated space platform missions are discussed. R.J.F.

N90-18338*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
RECOMMENDATIONS FOR THE FUTURE
In its Solar-Terrestrial Science Strategy Workshop Sep. 1989 p 65-66 (For primary document see N90-18329 10-88)
Avail: NTIS HC A04/MF A01; 4 functional color pages CSCL 03B

The workshop explored four major areas of concern to solar-terrestrial science. Looking across the discipline reports given previously, it is possible to find common threads that can contribute to the development of NASA's programmatic strategy for the solar-terrestrial sciences. The following areas are outlined: scientific balance; previously gathered information; imaging; impact of the space station and related platforms; vitality and relevance; and future studies. Author

N90-18339# Consiglio Nazionale delle Ricerche, Frascati (Italy). Ist. di Fisica dello Spazio Interplanetario.
[ACTIVITIES REPORT OF THE INSTITUTE OF INTERPLANETARY STELLAR PHYSICS] Annual Report, 1987 [RELAZIONE SULL'ATTIVITA SCIENTIFICA ORDINARIA SVOLTA NELL'ANNO 1987]
Dec. 1988 146 p In ITALIAN
(IFSI-88-22; ETN-90-96161) Avail: NTIS HC A07/MF A01

The current research projects are summarized. The research is grouped into four main directions: infrared astronomy, interplanetary media, cosmic rays and gravitational fields. ESA

N90-18340# Consiglio Nazionale delle Ricerche, Frascati (Italy). Ist. di Fisica dello Spazio Interplanetario.
SCIENTIFIC ACTIVITY PROGRAMS FOR 1988-1990 [PROGRAMMI DI ATTIVITA' SCIENTIFICA TRIENNIO 1988-1990]
Dec. 1988 76 p In ITALIAN
(IFSI-88-23; ETN-90-96162) Avail: NTIS HC A05/MF A01

The research is grouped into four main directions: infrared astronomy, interplanetary media, cosmic rays and gravitational fields. The programs include new technologies for space instruments, a plasma camera, interactions of comets with solar wind and plasmas, analysis of cosmic radiation from Rome station data, study of star forming regions, galactic evolution and gravitational antennas. ESA

N90-18341# Consiglio Nazionale delle Ricerche, Frascati (Italy). Ist. di Fisica dello Spazio Interplanetario.
SCIENTIFIC ACTIVITY PROGRAM FOR 1989 [PROGRAMMA DI ATTIVITA' SCIENTIFICA ANNO 1989]
Apr. 1989 69 p In ITALIAN
(IFSI-89-10; ETN-90-96172) Avail: NTIS HC A04/MF A01

The current research projects are summarized. The research is grouped into four main directions: infrared astronomy, interplanetary media, cosmic rays and gravitational fields. The projects include instruments for the Infrared Space Observatory (ISO) satellite, problems of star formation and star evolution, Tethered Satellite System (TSS) experiment, Opera experiment, propagation of cosmic rays in the inonosphere, design of a solar neutron detector, and gravitational wave antennas experiments. ESA

89 ASTRONOMY

Includes radio, gamma-ray, and infrared astronomy, and astrometry.

N90-18342*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
FIFTY YEAR CANON OF LUNAR ECLIPSES: 1986-2035
Fred Espenak Mar. 1989 221 p
(NASA-RP-1216; Rept-89B00056; NAS 1.61:1216) Avail: NTIS HC A10/MF A02 CSCL 03A

A complete catalog is presented, listing the general circumstances of every lunar eclipse from 1901 through 2100. To compliment this catalog, a set of figures illustrate the basic Moon-shadow geometry and global visibility for every lunar eclipse over the 200 year interval. Focusing in on the next fifty years, 114 detailed diagrams show the Moon's path through Earth's shadow during every eclipse, including contact times at each phase. The accompanying cylindrical projection maps of Earth show regions of hemispheric visibility for all phases. The appendices discuss eclipse geometry, eclipse frequency and recurrence, enlargement of Earth's shadow, crater timings, eclipse brightness and time determination. Finally, a simple FORTRAN program is provided which can be used to predict the occurrence and general characteristics of lunar eclipses. This work is a companion volume to NASA Reference Publication 1178: Fifty Year Canon of Solar Eclipses: 1986-2035. Author

N90-18343# Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil). Ministerio da Ciencia e Tecnologia.
RADIO CONTINUUM MAPS AT 22 GHz OF THE H II REGIONS RCW57 AND W49 M.S. Thesis
Nanci Solange PradoSabalisck Jan. 1989 88 p In PORTUGUESE; ENGLISH summary
(INPE-4787-TDL/353) Avail: NTIS HC A05/MF A01

The galactic regions W49 and RCW57 are studied at the radio continuum frequency of 22 GHz, with a half power beam width of the order of 4 minutes, in the Radio Observatorio do Itapetinga. The analysis of the obtained spectra confirmed that the sources G291.0-0.1 and G43.03-0.2 (W49B) are Plerionic type supernova remnants. The strong emission of the H II region G291.6-0.5 occurs next to compact source G291.59-0.5, which presented a low level integrated flux density at 141 MHz. The integrated flux density obtained for the H II region region W49 indicated that, compared to lower frequencies, the contribution of new compact sources is not important at 22 GHz. Author

90 ASTROPHYSICS

Includes cosmology; celestial mechanics; space plasmas; and interstellar and interplanetary gases and dust.

For related information see also *75 Plasma Physics*.

N90-18344*# National Aeronautics and Space Administration, Washington, DC.
FGK STARS AND T TAURI STARS: MONOGRAPH SERIES ON NONTHERMAL PHENOMENA IN STELLAR ATMOSPHERES
Lawrence E. Cram, ed. and Leonard V. Kuhi, ed. (California Univ., Berkeley.) 1989 353 p Prepared in cooperation with Centre National de la Recherche Scientifique, Paris, France
(NASA-SP-502; NAS 1.21:502; LC-89-600317) Avail: NTIS HC A16/MF A02; also available SOD HC $18.00 as 033-000-01073-7 CSCL 03B

The purpose of this book, FGK Stars and T Tauri Stars, like all other volumes of this series, is to exhibit and describe the best space data and ground based data currently available, and also to describe and critically evaluate the status of current theoretical models and physical mechanisms that have been proposed to interpret these data. The method for obtaining this book was to collect manuscripts from competent volunteer authors, and then to collate and edit these contributions to form a well structured book, which will be distributed to an international community of research astronomers by NASA and by the French CNRS. Author

N90-18345 Colorado Univ., Boulder.
NUCLEAR DRIVING OF STELLAR OSCILLATIONS AND THEIR COUPLING TO CONVECTION Ph.D. Thesis
William James Merryfield 1988 285 p
Avail: Univ. Microfilms Order No. DA8912209

The nonlinear behavior of gravity mode oscillations in the deep interior of the sun is examined. Such modes may be self-excited by their ability to extract energy from nuclear burning of He-3 in the core, and have been hypothesized to lead to core mixing, perhaps accounting for the observed deficit of solar neutrinos. Their nonlinear evolution was studied through a detailed bifurcation analysis of a simplified incompressible model. Several nonlinear feedbacks are identified which compete to limit the amplitude of the mode near marginal stability, so that runaway growth, perhaps leading to mixing, does not occur. The inferred limiting amplitude corresponds to a maximum vertical velocity of order 10 km/s in the solar core and a displacement amplitude of order 2 percent of the solar radius. Because such oscillations should be easily detectable at the solar surface, it is concluded that the He-3 driving mechanism probably is not operating in the sun during the present epoch. These findings are confirmed by numerically solving the model equations. These numerical results also suggest that if He-3-driven oscillations are linearly unstable, then the degeneracy in linear theory between left and right-traveling waves is broken by nonlinear effects. The oscillation thus develops into a purely traveling wave rather than a standing wave or other superposition of horizontally-propagating waves. Dissert. Abstr.

N90-18346# Franklin Inst., Newark, DE.
PARTICLE THEORY AND COSMOLOGY Progress Report
1989 36 p
(Contract DE-AC02-78ER-05007)
(DE90-005338; DOE/ER-05007/26) Avail: NTIS HC A03/MF A01

Progress is discussed in the following areas: non-accelerator physics and particle phenomenology; particle physics and cosmology; theories with higher symmetry; and astroparticle physics. DOE

N90-18347# California Univ., Berkeley. Lawrence Berkeley Lab. Nuclear Science Div.
STRANGE-QUARK-MATTER STARS
Norman K. Glendenning Nov. 1989 25 p Presented at the International Workshop on Relativistic Aspects of Nuclear Physics, Rio de Janeiro, Brazil, 28-31 Aug. 1989
(Contract DE-AC03-76SF-00098)
(DE90-006102; LBL-27959; CONF-8908148-4) Avail: NTIS HC A03/MF A01

The implications were investigated of the rapid rotation corresponding to the frequency of the new pulsar reported in the supernovae remnant SN1987A. It places very stringent conditions on the equation of state if the star is assumed to be bound by gravity alone. It was found that the central energy density of the star must be greater than 13 times that of nuclear density to be stable against the most optimistic estimate of general relativistic instabilities. This is too high for the matter to consist of individual hadrons. It is concluded that it is implausible that the newly discovered pulsar, if its half millisecond signals are attributable to rotation, is a neutron star. It is shown that it can be a strange quark star, and that the entire family of strange stars can sustain high rotation if strange matter is stable at an energy density exceeding about 5.4 times that of nuclear matter. The conversion of a neutron star to strange star is discussed along with the possible existence of a crust of heavy ions held in suspension by centrifugal and electric forces, the cooling and other features. DOE

N90-18348# Panametrics, Inc., Waltham, MA.
DEVELOPMENT AND USE OF DATA ANALYSIS PROCEDURES FOR THE CRRES (COMBINED RELEASE AND RADIATION EFFECTS SATELLITE) PAYLOADS AFGL-701-2/DOSIMETER AND AFGL-701-4/FLUXMETER AND APPLICATION OF THE DATA ANALYSIS RESULTS TO IMPROVE THE STATIC AND DYNAMIC MODELS OF THE EARTH'S RADIATION BELTS Scientific Report, No. 1
Bronislaw K. Dichter and Frederick A. Hanser 2 Oct. 1989 16 p
(Contract F19628-87-C-0169)
(AD-A215953; GL-TR-89-0247) Avail: NTIS HC A03/MF A01 CSCL 03/2

The Earth's magnetospheric radiation environment is a major hazard for spaceborne electronic systems. This report documents work aimed at providing the U.S. Air Force with accurate, time dependent radiation belt and cosmic ray environmental specifications. The data for this effort is obtained from two instruments to be flown aboard the Combined Release and Radiation Satellite (CRRES). These instruments are the Energetic Particle Dosimeter and the High Energy Fluxmeter. GRA

N90-18349# Arizona Univ., Tucson.
DETECTING EXTENDED SOLAR SYSTEM STRUCTURES WITH COBE (COSMIC BACKGROUND EXPLORER) Scientific Report No. 4
Mark V. Sykes 29 Nov. 1989 17 p Submitted for publication
(Contract F19628-87-K-0045; AF Proj. S321)
(AD-A216380; GL-TR-89-0327; SR-4) Avail: NTIS HC A03/MF A01 CSCL 03/2

The Cosmic Background Explorer (COBE) offers a new opportunity for the study of extended solar system structures discovered by the Infrared Astronomical Satellite (IRAS). It is expected that of these structures, Type 2 dust trails may be detected by the Diffuse Infrared Background Experiment (DIRBE), in which case there will be a final chance to discover their parent sources, which are as yet unknown, by immediate follow-up from groundbased imaging along the trail. Zodiacal dust bands will be easily detected at most wavelengths by DIRBE, allowing for additional analysis of their structure and geometry, as well as comparison at near-infrared wavelengths with the spectra of asteroid family members from which they are thought to derive. The other COBE experiments, as a consequence of their large beam sizes and long operating wavelengths, are not expected generally to detect these structures in the broad zodiacal emission. GRA

91 LUNAR AND PLANETARY EXPLORATION

Includes planetology; and manned and unmanned flights.
For spacecraft design or space stations see *18 Spacecraft Design, Testing and Performance.*

N90-18350*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
TECHNOLOGY DEVELOPMENT, DEMONSTRATION, AND ORBITAL SUPPORT REQUIREMENTS FOR MANNED LUNAR AND MARS MISSIONS
Charles P. Llewellyn (Analytical Mechanics Associates, Inc., Hampton, VA.) and Karen D. Brender Feb. 1990 13 p Proposed for presentation at the Space 90 Conference, Albuquerque, NM, 23-26 Apr. 1990
(NASA-TM-101666; NAS 1.15:101666) Avail: NTIS HC A03/MF A01 CSCL 03B

An overview of the critical technology needs and the Space Station Freedom (SSF) focused support requirements for the Office of Exploration's (OEXP) manned lunar and Mars missions is presented. Major emphasis is directed at the technology needs associated with the low earth orbit (LEO) transportation node assembly and vehicle processing functions required by the lunar and Mars mission flight elements. The key technology areas identified as crucial to support the LEO node function include in-space assembly and construction, in-space vehicle processing and refurbishment, space storable cryogenics, and autonomous rendezvous and docking. Author

N90-18351# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
AN INVESTIGATION OF LONG TERM ORBITS ABOUT THE PLANET MARS USING A DYNAMIC ATMOSPHERE MODEL M.S. Thesis
Zoltan L. Farago Dec. 1989 179 p
(AD-A216111; AFIT/GA/ENY/89D-01) Avail: NTIS HC A09/MF A01 CSCL 22/3

This study examines the effects of atmospheric drag on the long term orbital motion of an artificial satellite about the planet Mars using a dynamic Martian atmosphere model instead of a static atmosphere model. Present studies of motion through the Martian atmosphere use a non-rotating (static) atmosphere model which has a simple exponential drop-off with altitude. However, Mars, like other planets, is known to have a turbulent, complex atmosphere. As a result, a new dynamic model of the Martian atmosphere uses data from recent space probes of Mars to simulate an atmosphere that is both position dependent, through latitude and longitude effects, and time dependent, through a variety of effects. These include diurnal and seasonal effects, annual motion effects, solar activity effects, and dust storm effects. Nine constituent gases are included in the above model. The model determines atmospheric mass density for the calculation of atmospheric drag. The existing static model is also used to calculate atmospheric drag to provide a comparison in conjunction with other effects. In addition to atmospheric drag, perturbations due to the attraction of the sun, the aspherical gravity field of Mars, and the effects of the solar wind are also modeled. The resulting orbital data are then compared to determine the differences between the two models, thus showing the effects on long term motion of using a dynamic model of the Martian atmosphere. GRA

N90-18352# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
STABLE ORBITS ABOUT THE MARTIAN MOONS M.S. Thesis
Scott W. Jansson Dec. 1989 126 p
(AD-A216400; AFIT/GA/ENY/89D-3) Avail: NTIS HC A07/MF A01 CSCL 22/3

Orbits about the Martian moons, Phobos and Deimos, were investigated using the Poincare' surface of section technique. Hamilton's canonical equations were derived to describe the dynamics of the modified restricted three-body problem (Mars, moon, artificial satellite). The surface of section technique involved the numerical integration of several test orbits with the same value for the Hamiltonian. Apoapsis and periapsis points of the orbits are plotted in the two-dimensional configuration space. Stable orbits were discovered when the points formed sets of closed curves; chaotic orbits were indicated by the scattering of the points. GRA

92 SOLAR PHYSICS

Includes solar activity, solar flares, solar radiation and sunspots.
For related information see *93 Space Radiation.*

N90-18353# Brown Univ., Providence, RI. Dept. of Physics.
RESEARCH AND DEVELOPMENT OF A HELIUM-4 BASED SOLAR NEUTRINO DETECTOR Progress Report, 1 May 1989 - 30 Apr. 1990
R. E. Lanou, H. J. Maris, and G. M. Seidel Dec. 1989 16 p
(Contract DE-FG02-88ER-40452)
(DE90-005416; DOE/ER-40452/4) Avail: NTIS HC A03/MF A01

This progress report covers the first six months of the May 1989 Continuation Grant. The purpose of the project is to develop and test a new detection technique for neutrinos using He-4 in

the superfluid state. Based upon the expected test results it should be possible to design a practical detector leading to the ultimate goal of detecting low energy solar neutrinos. During the last six months the construction phase has moved ahead substantially. Among the areas of progress discussed are: the construction of the cryostat and dilution refrigerators; the gas handling systems; computer system design; tests for radioactivity of construction materials; and roton pulse simulation by computer. DOE

N90-18354# Brown Univ., Providence, RI. Dept. of Physics.
PARTICLE DETECTION VIA ROTONS IN HELIUM-4 SUPERFLUID
R. E. Lanou, H. J. Maris, F. S. Porter, G. M. Seidel, C. A. Smith, and R. H. Torii 1988 3 p Presented at the Particle Astrophysics Workshop, Berkeley CA, 8-10 Dec. 1988 Submitted for publication
(Contract DE-FG02-88ER-40452)
(DE90-005417; DOE/ER-40452/2; CONF-881212-3) Avail: NTIS HC A01/MF A01

Any experiment to detect recoils from solar neutrinos or from elementary particle dark matter faces severe constraints. The combination of flux, cross section, and low kinetic energy of these particles leads to expectation of low event rates and low energy deposits in any detector. Consequently a suitable detector for such dark matter should possess a low content of intrinsic or spallation produced radioactivity, a low energy threshold, good energy resolution, good sensitivity (size vs. rate), a choice of integer or half integer spin targets, real time detection and good signal to noise discrimination. The design choices for any detector for this purpose depend on optimization of these competing requirements. A calorimeter detection method is discussed. DOE

N90-18355*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
PIONEERS 10 AND 11 DEEP SPACE MISSIONS
Palmer Dyal Feb. 1990 13 p Presented at the 1st COSPAR Colloquium, Warsaw, Poland, 19-22 Sep. 1989
(NASA-TM-102269; A-90043; NAS 1.15:102269) Avail: NTIS HC A03/MF A01 CSCL 03B

Pioneers 10 and 11 were launched from Earth, 2 March 1972, and 5 April 1973, respectively. The Pioneers were the first spacecraft to explore the asteroid belt and the first to encounter the giant planets, Jupiter and Saturn. The Pioneer 10 spacecraft is now the most distant man-made object in our solar system and is farther from the Sun than all nine planets. It is 47 AU from the Sun and is moving in a direction opposite to that of the Sun's motion through the galaxy. Pioneer 11 is 28 AU from the Sun and is traveling in the direction opposite of Pioneer 10, in the same direction as the Sun moves in the galaxy. These two Pioneer spacecraft provided the first large-scale, in-situ measurements of the gas and dust surrounding a star, the Sun. Since launch, the Pioneers have measured large-scale properties of the heliosphere during more than one complete 11-year solar sunspot cycle, and have measured the properties of the expanding solar atmosphere, the transport of cosmic rays into the heliosphere, and the high-energy trapped radiation belts and magnetic fields associated with the planets Jupiter and Saturn. Accurate Doppler tracking of these spin-stabilized spacecraft was used to search for differential gravitational forces from a possible trans-Neptunian planet and to search for gravitational radiation. Future objectives of the Pioneer 10 and 11 missions are to continue measuring the large-scale properties of the heliosphere and to search for its boundary with interstellar space. Author

N90-18356# National Oceanic and Atmospheric Administration, Boulder, CO. Cooperative Inst. for Research in Environmental Sciences.
A STUDY OF THE EVOLUTION OF SOLAR ACTIVE REGIONS FOR IMPROVING SOLAR FLARE FORECASTS
Patricia L. Bornmann, Darren Kalmbach, David Kulhanek, and April Casale (Colorado Univ., Boulder.) 20 Dec. 1989 9 p Presented at the Solar Terrestrial Predictions Workshop, Leura, Australia, 16-20 Oct. 1989 Sponsored by Air Force Geophysics Lab., Hanscom AFB, MA
(AD-A216325; GL-TR-89-0337) Avail: NTIS HC A02/MF A01 CSCL 03/2

Statistics on the frequency of transition between active region classes were calculated and used to derive the expected rate of flaring for the next 2 to 7 days. Five years of McIntosh active region classifications were analyzed using the newly-developed software called TELSAR (Tracking and EvoLution of Solar Active Regions). The most frequent transitions between these 63 different classes usually involve a single-step change in one of the three classification parameters. The evolution of the classes and the average, single-day flare rate were used to predict flare rates for each class over the next several days. For flares of x ray class M, these rates can differ from persistence predictions by more than 0.5 flares per day, although a more typical difference is 0.1 flares per day. The rarity of some classes suggests that merging these classes with others may improve flare statistics and thereby improve flare forecasts. GRA

N90-18335*# Stanford Univ., CA.
REPORT FROM SOLAR PHYSICS
A. B. C. Walker, L. Acton, G. Brueckner, E. L. Chupp, H. S. Hudson, and W. Roberts (San Jose State Univ., CA.) *In* NASA, Marshall Space Flight Center, Solar-Terrestrial Science Strategy Workshop Sep. 1989 p 31-49 Original contains color illustrations (For primary document see N90-18329 10-88)
Avail: NTIS HC A04/MF A01; 4 functional color pages CSCL 03B

93 SPACE RADIATION

Includes cosmic radiation; and inner and outer earth's radiation belts.

For biological effects of radiation see *52 Aerospace Medicine*. For theory see *73 Nuclear and High-Energy Physics*.

N90-18357*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
RADIATION EXPOSURE FOR MANNED MARS SURFACE MISSIONS
Lisa C. Simonsen, John E. Nealy, Lawrence W. Townsend, and John W. Wilson Washington Mar. 1990 25 p
(NASA-TP-2979; L-16708; NAS 1.60:2979) Avail: NTIS HC A03/MF A01 CSCL 03B

The Langley cosmic ray transport code and the Langley nucleon transport code (BRYNTRN) are used to quantify the transport and attenuation of galactic cosmic rays (GCR) and solar proton flares through the Martian atmosphere. Surface doses are estimated using both a low density and a high density carbon dioxide model of the atmosphere which, in the vertical direction, provides a total of 16 g/sq cm and 22 g/sq cm of protection, respectively. At the Mars surface during the solar minimum cycle, a blood-forming organ (BFO) dose equivalent of 10.5 to 12 rem/yr due to galactic cosmic ray transport and attenuation is calculated. Estimates of the BFO dose equivalents which would have been incurred from the three large solar flare events of August 1972, November 1960, and February 1956 are also calculated at the surface. Results indicate surface BFO dose equivalents of approximately 2 to 5, 5 to 7, and 8 to 10 rem per event, respectively. Doses are also estimated at altitudes up to 12 km above the Martian surface where the atmosphere will provide less total protection. Author

N90-18358# International Centre for Theoretical Physics, Trieste (Italy).
SEARCH FOR PROTON DECAY AND SUPERNOVA NEUTRINO BURSTS WITH A LUNAR BASE NEUTRON DETECTOR
David B. Cline Jun. 1989 23 p Presented at the Meeting on Physics and Astrophysics Experiments from a Lunar Base, Stanford, CA, May 1989
(DE90-607644; IC-89/137) Avail: NTIS (US Sales Only) HC A03/MF A01

The current status is described of the search for proton decay on earth, emphasizing the decay mode P yields K(+) antineutrons and the possibility is discussed of detecting this mode with a single detector on a lunar base station. The same detector could be used to search for neutrino bursts from distant supernova using the neutral current signature muon antineutrino,tau + N yields n + neutrino sub x by detecting the produced neutrons. The key advantage of the lunar experiment is the low neutrino flux and possible low radioactive background. DOE

N90-18359# Argonne National Lab., IL. High Energy Physics Div.

CONTAINED EVENTS IN SOUDAN 2

W. W. M. Allison, G. J. Alner, I. Ambats, D. Ayres, L. Balka, G. D. Barr, W. L. Barrett, D. Benjamin, P. Border, and C. B. Brooks (Oxford Univ., England) et al 23 Aug. 1989 4 p Presented at the 21st International Cosmic Ray Conference, Adelaide, Australia, 6-19 Jan. 1990

(Contract W-31-109-eng-38)

(DE90-005648; ANL-HEP-CP-89-92; CONF-900122-8) Avail: NTIS HC A01/MF A01

A search for contained events in the Soudan 2 nucleon decay detector were made for the initial exposure of the first quarter of the 1.1 kiloton detector. This corresponds to an exposure of 0.083 kiloton years in the fiducial volume. Five nu(submu) candidate events and five nu(sub e) candidate events were observed. Results of Monte Carlo simulations of neutrino events and proton decay events in Soudan 2 were compared. DOE

N90-18360# Argonne National Lab., IL. High Energy Physics Div.

STUDIES OF (MU)(PRIME)S UNDERGROUND WITH THE SOUDAN 2 TRACKER

J. Kochocki, W. W. M. Allison, G. J. Alner, I. Ambats, D. Ayres, L. Balka, G. D. Barr, W. L. Barrett, D. Benjamin, and P. Border (Minnesota Univ., Minneapolis.) et al 23 Aug. 1989 4 p Presented at the 21st International Cosmic Ray Conference, Adelaide, Australia, 6-19 Jan. 1990

(Contract W-31-109-eng-38)

(DE90-005656; ANL-HEP-CP-89-93; CONF-900129-7) Avail: NTIS HC A01/MF A01

During the period July 1987 through March 1988, a section of the Soudan 2 active shield known as the Tracker recorded approx. 250,000 muon tracks. The detector is located in the Tower-Soudan State Park in Soudan, Minnesota USA at a depth of 2090 meters-water equivalent. The data collected was analyzed and time dependent astronomical sources were sought. Distributions in azimuthal and zenith angles as well as declination and right ascension are shown. DOE

99 GENERAL

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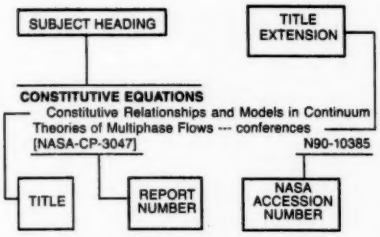

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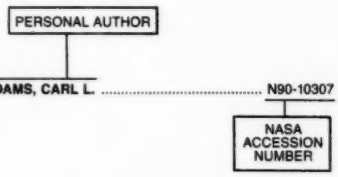

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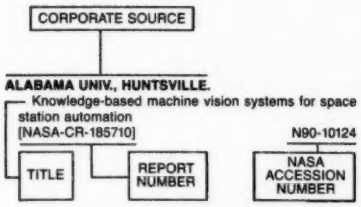

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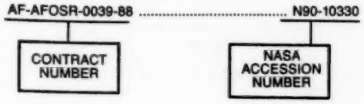

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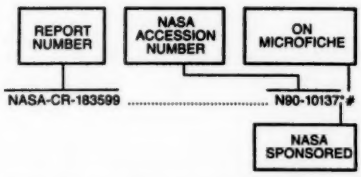

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